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MBA PROFESSIONAL REPORT

External Strategic Analysis of the Aviation Maintenance, Repair and Overhaul (MRO) Industry and Potential Market Opportunities for Fleet Readiness Center Southwest

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13. ABSTRACT (maximum 200 words)

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Strategy development is dependent upon a solid, current and complete industrial analysis. An industrial analysis includes, 1) a definition of the industry, 2) a description of external forces acting upon the industry, 3) a description of the industry structure and 4) an examination of the key success factors that benchmark the requirements for a firm to stay competitive in the industry. These analyses provide FRCSW with the information required to leverage their core competencies to indentify and capitalize on potential opportunities in the industry.

This study identifies emerging trends, presents projected forecasts, identifies external forces on both the military aviation MRO industry and FRCSW, and discusses those factors that are key to long term success in the military aviation MRO industry. The conclusions present a number of opportunities for FRCSW to explore in their effort to remain the Navy's premier aviation depot.

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EXTERNAL STRATEGIC ANALYSIS OF THE AVIATION MAINTENANCE, REPAIR AND OVERHAUL (MRO) INDUSTRY AND POTENTIAL MARKET OPPORTUNITIES FOR FLEET READINESS CENTER SOUTHWEST

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LIST OF ABBREVIATIONS AND ACRONYMS

AIMD	Aircraft Intermediate Maintenance Department
ALC	Air Logistics Center
AMRO	Aviation Maintenance, Repair and Overhaul
ASNRD&A	Assistant Secretary of the Navy for Research Development & Acquisitions
BRAC	Base Closure and Realignment
CBR+	Center Barrel Replacement Plus
CITE	Center of Industrial and Technological Excellence
CNAF	Commander Naval Air Forces
CO	Commanding Officer
D-level	Depot Level
D2I	Depot to Intermediate
DoD	Department of Defense
FMC	Fully Mission Capable
FMS	Foreign Military Sales
FRC	Fleet Readiness Center
FRCE	Fleet Readiness Center East
FRCMA	Fleet Readiness Center Mid-Atlantic
FRCNW	Fleet Readiness Center Northwest
FRCSE	Fleet Readiness Center Southeast
FRCSW	Fleet Readiness Center Southwest
FRCW	Fleet Readiness Center West
GAO	Government Accountability Office

HASC	House Armed Services Committee
I-level	Intermediate Level
ISR	In-Service Repair
ISSC	In-Service Support Center
KSF	Key Success Factors
MATCOM	U.S. Marine Corps Materiel Command
MRO	Maintenance, Repair and Overhaul
NADEP	Naval Aviation Depot
NPSL	Navy Primary Standards Laboratory
O-level	Organizational Level
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PEST	Political, Economic, Social, Technological
PMI	Planned Maintenance Interval
SASC	Senate Armed Services Committee
SECDEF	Secretary of Defense
SLEP	Service Life Extension Program
SR/CD	Special Rework / Crash Damage
SYSCOM	Systems Command
UAV	Unmanned Aerial Vehicle
U.S.C.	United States Code

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I. INTRODUCTION

A. PURPOSE

The purpose of this MBA professional report is to supplement the long- and short-range strategic development efforts of Fleet Readiness Center Southwest (FRCSW) by providing command leadership with an analysis of the current aviation maintenance, repair and overhaul industry to identify potential expansion opportunities for FRCSW.

An industry analysis provides FRCSW a useful tool in developing the new strategy required by the implementation of changes made by the passage of revisions to United States Code (U.S. Code) Title 10 in 2002; requiring the Department of Defense (DoD) to establish Centers of Industrial and Technological Excellence (CITEs) that will compete with private commercial firms for maintenance repair contracts.[1] The competition opened up by the new Title 10 laws required all military depots to reassess how they were operating and begin to shift from the full-funding methods used throughout the Cold War to a business-style approach that took into account competition and strategy. Development of this new brand of strategy began in earnest for FRCSW with its submission for the Malcom Baldrige National Quality Award in 2008. The Malcom Baldrige award requires applicants to submit a response that details the process by which management develops internal strategy keyed toward long-term success in a competitive marketplace. Application for the award requires that the contender develop, understand and successfully implement a competitive internal strategic process; the contender must describe in detail this process to the award committee. While the Baldrige award helps to direct management in the realm of internal strategy, it does not provide adequate direction to develop a business's external strategy. This project provides the necessary information required for the business team at FRCSW to develop an appropriate external competitive strategy.

[1] Title 10 and CITE issues will be discussed further in Chapter III.

B. ELEMENTS OF AN INDUSTRY ANALYSIS

The development of an external strategy is dependent upon a solid, current and complete industrial analysis. Development of an industrial analysis requires, 1) a definition of the industry, 2) a description of external forces acting upon the industry, 3) a description of the industry structure and 4) an examination of the key success factors that benchmark the requirements for a firm to stay competitive in the industry.

1) Defining the industry is done by establishing boundaries within which the industry operates, namely the products and markets that describe the domain of the industry. Once clearly defined, the domain of the industry provides a forum within which an analysis of the capabilities required to participate in the industry can be assembled. Definition of the products, markets and capabilities provide the parameters within which the industry can be effectively analyzed.

2) Describing the external forces on the industry begins by defining the overarching industry structure through an examination of the five-forces of competition acting on the industry (Porter, 1980). These five forces were defined by Michael Porter in the 1980s as the threat of new entrants, threat of existing rivals, threat of substitute products, bargaining power of the buyer, and bargaining power of the suppliers (Porter, 1980).

3) Once the five-forces are defined and analyzed for the individual industry, the structure of the industry can then be developed through an analysis of the macro-factors acting on the industry. The macro-factors are examined through use of a PEST analysis, wherein the external factors of political, economic, social, technological, environmental and legal pressures are examined.

4) An examination of the industry structure provides a forum within which the factors that determine the success of a business in the industry can be analyzed. These key success factors are those things that directly impact the ability of a business to be successful in its specific industry. Identifying the key success factors is critical to

understanding what makes a firm viable in the long-term. An industry analysis concludes with recommendations for possibilities that exploit the key success factors the firm already possesses.

C. FLEET READINESS CENTER SOUTHWEST'S POSITION IN THE MAINTENANCE, REPAIR AND OVERHAUL INDUSTRY

In 2007, $117 billion was spent in the Aviation Maintenance, Repair and Overhaul (AMRO) industry worldwide (Michaels, 2008). The United States DoD was by far the largest single consumer of these services at $31 billion (Chrisman, 2008). The United States DoD operates a fleet of 13,521 aircraft, making it far and away the largest fleet of aircraft in the world (*Aviation Week & Space Technology*, 2009). Due to the size of the U.S. aircraft fleet, the DoD has internalized the majority of the maintenance and repair of their aircraft for all branches of the military.

Each branch of the DoD conducts its own aircraft maintenance with the exception of the Marines, which use the Navy MRO facilities to conduct intermediate and depot level maintenance. The Air Force utilizes three major facilities, designated as Air Logistics Centers (ALC), to conduct its depot level maintenance. The Air Force divides work by designating an ALC as a Center of Industrial and Technical Excellence (CITE) for specific airframes and specific components. For example, Ogden ALC is the CITE for A-10 Thunderbolt II, B-2 Spirit, F-16 Fighting Falcon, and components, such as landing gear systems and composite materials.

The Army conducts all rotary wing aviation depot maintenance at Corpus Christi Army Depot, the Army's CITE for rotary wing maintenance. The Army contracts civilian aviation depots to conduct all depot level maintenance on its limited fixed wing assets.

The Navy utilizes a series of three major depots (FRCSW North Island, FRCE Cherry Point and FRCSE Jacksonville), three minor depots (FRCW Lemoore, FRCNW Whidbey Island and FRCMA Oceana) and numerous smaller depots at stations across the

United States. These Navy depots are referred to as Fleet Readiness Centers (FRCs) and are divided into geographic regions and commands, as shown in Figure 1.

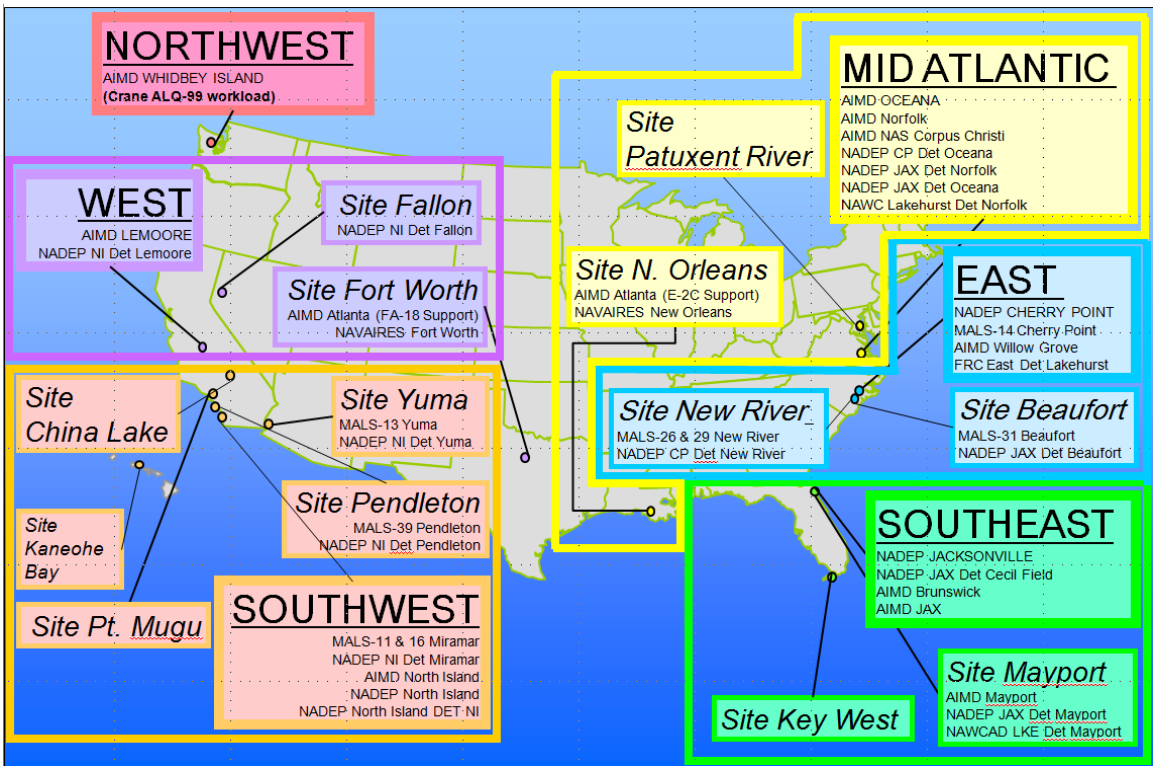

Figure 1. FRC Command Structure (From: Kelly, 2008)

The Navy utilizes a combination of single CITE and fleet-basing systems for determining which depot will conduct maintenance. This means that the Navy maintains capabilities for depot-level repair of a single airframe at multiple locations in support of fleet basing. This is supplemented by designation of CITE locations for components and airframes that provide the resident technical expertise to support depot level maintenance and provide this expertise to other FRCs as needed. FRCSW is designated as the depot to conduct intermediate and depot level maintenance for all aircraft in the Southwest.

D. FLEET READINESS CENTER SOUTHWEST[2]

The depot-level maintenance functions of FRCSW are nearly as old as Naval Aviation itself. In 1919, nine years after the start of Naval Aviation, the FRC began work as an Assembly and Repair Department of the Naval Air Station at North Island. In 1969, the Assembly and Repair Department was renamed the Naval Air Rework Facility (NARF). By 1987, the NARF was renamed the Naval Aviation Depot (NADEP) North Island (Fleet Readiness Center Southwest, 2007). As result of Base Closure and Realignment (BRAC) 2005, NADEP North Island was disestablished and realigned into FRCSW (Moore, 2008).

Recognized as an innovator in depot-level maintenance by the Office of Naval Research's Best Manufacturing Practices Program, FRCSW is the Navy's primary west coast aircraft repair and modification facility for mission-essential fighter and rotary wing aircraft for Navy and Marine Corps squadrons (Moore, 2008). As of December 2007, FRCSW employed 4,371 people consisting of 3,494 civilian employees and 877 military personnel. The mission of the Fleet Readiness Center Southwest is:

> …CNAF's [Commander Naval Air Forces] West Coast Aircraft Repair D2I [Depot to Intermediate] facility specializing in the support of Navy and Marine Corps aircraft and related systems. Through partnerships with industry, other government agencies and supporting aerospace organizations, FRC Southwest, North Island repairs and overhauls aviation systems (Fleet Readiness Center Southwest, 2007).

FRCSW performs repair and modifications work on F/A 18 Hornets and Super Hornets, EA-6B Prowlers, E-2 Hawkeyes, C-2 Greyhounds, AV-8B Harriers, SH-60 Seahawks and HH/MH-60s, AH-1 Cobras, UH/HH Hueys, and CH-53 Sea Stallions. Additionally, FRCSW deploys Field Service Teams and Voyager Repair Teams to deployed aviation squadrons, ships, and installations worldwide. The Field Service and Voyager Repair Teams provide depot-level maintenance repair and modification for aircraft, aviation structures, aircraft components, aircraft carrier catapult and arresting gear systems, and aviation equipment and facilities on other ships (Fleet Readiness

[2] Section B with minor modifications is drawn directly from T. Curran and J. J. Schimpff, "An Analysis of Factors Generating the Variance between the Budgeted and Actual Operating Results of the Naval Aviation Depot at North Island, California," (MBA Project, Naval Postgraduate School, 2008), 5-8.

Center Southwest, 2007). In 2007, FRCSW deployed over 2,500 Field Service and Voyager Repair Teams, repaired and modified approximately 285 aircraft, and manufactured over 50,000 aircraft components (Fleet Readiness Center Southwest, 2007).

1. FRCSW Programs

The FRCSW receives aircraft, engines and a multitude of components from activities within the U.S., as well as forward deployed units, for maintenance, modification and repair needed from normal operations or battle related damage. Requests to manufacture new replacement items for components that can no longer be repaired, refurbished or are not commercially available are also received from fleet units as well as other DoD components. These demands are satisfied by the services provided through one or more of the following seven FRCSW programs (Fleet Readiness Center Southwest, 2007).

a. Components Program

The components program at FRCSW has the capabilities to repair and refurbish over 19,000 different types of Navy, Marine Corps aircraft components, supply systems and DoD assets. The Components Department existed as a program within the Depot prior to the merger. As a result of the FRC implementation, the AIMD (Aircraft Intermediate Maintenance Department) repair capabilities and the Depot artisan (worker) skills are integrated into a single organization. The new organization has personnel, equipment and facilities specialized in the repair and refurbishment of Avionics, Aircraft Supports and Surfaces, Instruments and Generators, Landing Gear and Hydraulics components for units ashore and afloat.

b. E-2/C-2 Program

The E-2/C-2 Program is comprised of five groups that include 1) PMI One and Two for repair and refurbishing (PMI-1/2), 2) PMI-3/Service Life Extension Program (SLEP)/Rewire (C-2), 3) In-Service Repair (ISR), 4) Foreign Military Sales (FMS), and 5) E-2 Super Modules.

c. F/A-18 Program

The F/A-18 Program supports PMI-1/-2 Special Rework/Crash Damage Repair (SR/CD) and Center Barrel Replacement Plus (CBR+).

d. Manufacturing Program

The Manufacturing Program has machining, sheet metal fabrication, tube/hose/duct repair, foundry, welding and heat treatment capabilities that support the aircraft and helicopter rework programs as well as the overhaul of the LM2500 marine gas turbine engine used on surface naval ships. This department also manufactures and repairs over 150 different configurations of mobile VANS, large steel containers with special equipment that support deployed Marine Corps Units.

e. Engineering and Logistics Program

The Engineering and Logistics Program is part of the In-Service Support Center (ISSC) and consists of a full Materials Laboratory and the Navy Primary Standards Laboratory (NPSL). This program is responsible for developing the safest, most reliable and cost-effective engineering solutions needed to meet or exceed the repair, refurbishment and modifications requirement for products.

f. Multi-Line Program

The Multi-Line Program supports PMI-1/-2 for UH-1/HH-1 Huey, CH-53 Super Stallion, AH-1W Super Cobra and SH-60/MH-60/HH-60 Seahawk helicopters for the Navy and Marine Corps.

g. Field Service/Voyager Repair Program

The Field Service/Voyager Repair Program is comprised of Voyager Repair teams, Field Service teams, paint/finish and surface/structural repair support for AV-8B Harrier aircraft in Yuma, Arizona.

E. CHAPTER CONTENTS

This report is presented in seven chapters. Chapter I is a discussion of the purpose of the report followed by the definition of an industry analysis, a brief introduction to FRCSW's position in the AMRO market and finally the current offerings at FRCSW. Chapter II provides an overview of both the commercial and military AMRO industries by market segment. Chapter III includes a discussion about aviation maintenance in the U.S. Navy, specifically the levels of maintenance and the evolution of public/private partnerships. Chapter IV presents an analysis of the military AMRO market by examining the competitive forces acting upon participants in the market and specifically FRCSW. The forces discussed in Chapter IV will include the bargaining power of the suppliers, bargaining power of the buyers, threat of new entrants into the industry, threat of substitute products, and current industry rivals. Chapter V presents an analysis of the military AMRO market by examining the macro-environment within which the industry operates. This examination is done by discussing the impact of the following factors: Politics, Economy, Social, and Technology, known as a PEST analysis. Chapter VI identifies the Key Success Factors, those factors that are required for a business, specifically FRCSW, to remain competitive in the AMRO industry. Chapter VII summarizes the findings and presents FRCSW with recommendations as well as presenting future opportunities for research to supplement our findings.

II. THE AVIATION MAINTENANCE, REPAIR AND OVERHAUL INDUSTRY

A. INTRODUCTION TO AMRO

To strategically plan, a firm must first fully analyze the industry within which it competes in order to recognize both emerging industry trends and future market forecasts (Palmer & Kaplan, 2007). An innovative firm will look beyond its current market position, taking a holistic approach to strategic planning, to identify current trends or create future trends. "To capitalize on the latent opportunities that reside within trends, organizations must move beyond a uni-dimensional understanding of the future (Kaplan & Johnston, 1998)." Strategic planning requires a firm to look forward and make estimates about the direction of the industry within which they compete. Planning is a continuous activity that requires a firm to "engage in processes that define an explicit linkage between the evolving external environment, potential growth opportunities, and business strategies/tactics (InnovationPoint, 2007)." The AMRO industry is comprised of private firms competing for work in both defense and commercial markets, and military depots competing for work in the defense market. Military aviation depots are government (DoD) owned and are operated to fulfill the maintenance requirements set forth by the individual services aviation enterprise. The primary mission of these depots is to provide MRO services to military aircraft through application of their own core competencies. Each service has its own unique aviation depot capability with the exception of the U.S. Marine Corps, whose aircraft are serviced by Naval Aviation depots.

Private firms own and operate facilities and equipment to provide AMRO services to commercial airline operators and supplement military aviation depots through public/private partnerships[3]. These firms are organized and operated as follows: 1) an in-house subsidiary of a corporate airline operator, 2) an Original Equipment Manufacturer (OEM), or 3) a Third Party Independent. Commercial airlines can establish in-house

[3] Public/Private Partnerships are discussed further in Chapter III.

maintenance capabilities to provide AMRO services to their own fleets and to operate as profit centers; although it is not uncommon for airlines operators to spin-off these AMROs to act as a separate corporate activity (Carpenter & Henderson, 2008). In-house AMROs most closely resemble the capability offered by military AMRO depots. OEM's provide original equipment such as engines and avionic components to aircraft manufacturers during original assembly and offer maintenance support during the life-cycle of the aircraft. These OEMs are able to bundle services at the point of sale and provide superior technical capabilities (Carpenter & Henderson, 2008). Third Party Independents perform similar functions as In-house AMROs but are not affiliated with an airline operator. Independents often provide these services at a lower price. Therefore, independents market themselves as the value proposition over the OEMs and In-house MROs (Carpenter & Henderson, 2008). This relationship is displayed in Figure 2.

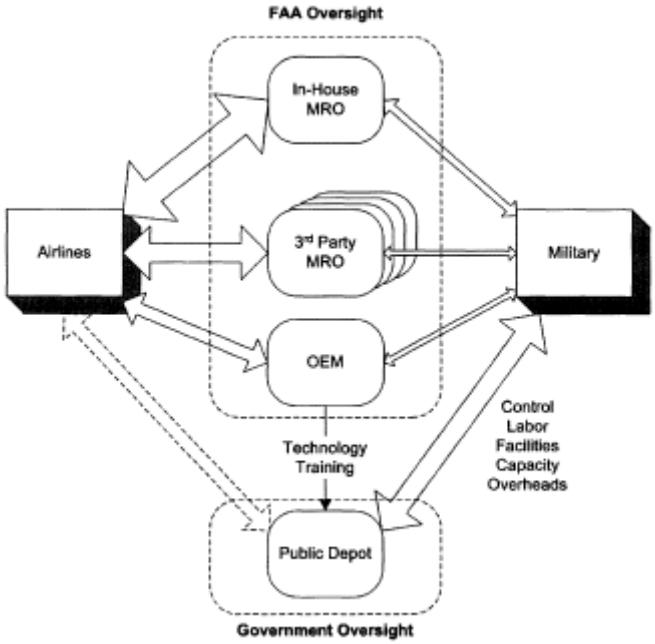

Figure 2. Commercial AMRO Industry (From: Choo, 2004)

B. MARKET SEGMENTS

The following sections analyze the military and commercial AMRO markets segments, current industry trends and future market forecast.

1. Military AMRO Market and Segments

Governments spent an estimated $1.1 trillion on global defense budgets in 2005, of which operations, maintenance and personnel to support military weapon systems accounted for 71 percent (Stewart, 2005). During this same time period Operations and Maintenance (O&M) for all U.S. weapon systems accounted for approximately 40 percent, or $210 billion, of the total U.S. DoD budget; "O&M funding is considered one of the major components of funding for readiness. O&M appropriations fund the training, supply, and equipment maintenance of military units as well as the infrastructure of military bases" (Lepore, 2007). Depot level AMRO is a component of O&M.

In 2008, the global military aircraft inventory exceeded 39,000 aircraft with maintenance on these aircraft costing governments $60.7 billion (Chrisman, 2008). The U.S. accounted for half of this, spending an estimated $31 billion on military AMRO in 2008. The next largest individual country was Japan which spent an estimated $2.5 billion during this period.

The military AMRO market has four segments: 1) Engines, 2) Components, 3) Airframes, and 4) Field Maintenance. The four segments conducted at military depots are defined below:

- *Field Maintenance.* Field maintenance, the largest military AMRO segment, is primarily conducted at the Intermediate and Organizational level, therefore, it is not covered.
- *Airframe*. Airframe maintenance is the second largest MRO segment, accounting for $11.7 billion of global military AMRO spend in 2008 (Chrisman, 2008). This segment is dominated by fixed wing fighter/attack and rotary wing transport/utility aircraft which comprised over 50 percent of all airframe maintenance (Chrisman, 2008). Airframe maintenance is

manpower intensive and is conducted by military depots or private firms depending on the organic capability of the nation owning the aircraft (Stewart, 2005).

- *Components*. Components are the third largest AMRO segment, accounting for $9.6 billion of global military AMRO spend in 2008 (Chrisman, 2008). This segment includes, but is not limited to, overhaul and repair of major components such as avionics, landing gear and associated hydraulic and pneumatic systems, wheels and brakes. Component MRO is performed by military depots and OEM's (Stewart, 2005).

- *Engines*. Engine maintenance is the smallest AMRO segment, accounting for $8.1 billion of global military AMRO spend in 2008 (Chrisman, 2008). This segment is consolidated; General Electric (41 percent) and Pratt & Whitney (29 percent) make-up the majority of the segment. Engine maintenance is classified as on-aircraft or off-aircraft and, depending on the level of complexity, can be conducted by all levels of military maintenance and by OEM's (Stewart, 2005).

2. Commercial AMRO Market and Segments

The global commercial AMRO industry, valued at $45.1 billion in 2008, is highly dependent upon the fiscal health of the commercial airline industry (Doan, 2008). In 2007 the airline industry realized its first profits since 2001 (Doan, 2007). The commercial airline industry had spent the previous six years recovering from the negative affects the events of September 11, 2001 had on global airline travel.

The global commercial airline fleet inventory includes more than 18,000 aircraft and is segmented into three categories: 1) Narrow body, 2) Wide body and 3) Regional jets (Marcontell, 2009). A narrow body aircraft has a cabin diameter between 10 and 13 feet and accounts for 60 percent of the fleet (Marcontell, 2009). Narrow body aircraft capacity ranges from 100 to 250 passengers and can be used in short, medium and long-haul commutes. A wide body aircraft has a cabin diameter between 16 and 20 feet and

accounts for 23 percent of the fleet (Marcontell, 2009). Wide body aircraft capacity ranges from 200 to 600 passengers and are generally used in long-haul commutes. Regional jet is a term used to describe a varying array of smaller aircraft used primarily in shorter, regional commutes (Office of the Assistant Secretary For Aviation and International Affairs, 1998). These aircraft generally range in capacity between 16 and 120 passengers.

The global commercial AMRO market is concentrated, with North America (37 percent) and Western Europe (27 percent) accounting for nearly two-thirds of all AMRO work performed in 2007 (Doan, 2008). AMRO services cost commercial airline operators between $300 and $1,800 per flight hour depending on the type, age and condition of the aircraft (Carpenter & Henderson, 2008). These expenditures, along with fuel and labor, comprise the majority of operating cost for commercial airlines.

The commercial AMRO industry has four segments: 1) Line Maintenance, 2) Heavy Maintenance, 3) Components and 4) Engines. The four segments conducted at commercial AMRO's are defined below:

- *Line Maintenance*. "Line maintenance diagnoses and corrects troubles on the aircraft and carries out minor and major aircraft checks and repairs" (Carpenter & Henderson, 2008). Line maintenance is very labor intensive and, in 2008, accounted for 18 percent, or $8.1 billion, of the global commercial AMRO market (Doan, 2008).

- *Components*. "Component maintenance refers to repairs made to components such as wheels, brakes and interior components (Carpenter & Henderson, 2008)." Component maintenance is often very technical in nature and, in 2008, accounted for 19 percent, or $8.7 billion, of the global commercial AMRO market (Doan, 2008).

- *Heavy Maintenance.* "Heavy maintenance encompasses structural modifications, landing gear repair, engine changes and regular calendar checks (Carpenter & Henderson, 2008)." Heavy maintenance is labor

intensive and, in 2008, accounted for 21 percent, or $9.1 billion, of the global commercial AMRO market (Doan, 2008).

- *Engines*. "Engine maintenance includes dismantling, inspecting, assembling and testing aircraft engines (Carpenter & Henderson, 2008)." Engines represent the largest segment and, in 2008, accounted for 42 percent, or $18.8 billion, of the global commercial AMRO market (Doan, 2008).

C. AMRO INDUSTRY TRENDS

- *Outsourcing*. Military depots and private firms are increasingly seeking opportunities to outsource services they do not consider to be core competencies. "An increase in the level of outsourcing is believed to be driving growth in the global aircraft MRO market. Outsourcing provides total cost advantage, offers more flexibility to operators, gives independent MROs opportunity to form credible network and affords key advantages to larger players. Independent MROs have the ability to offer more value[4]. Large players will adapt to possible additional regulations that may moderate outsourcing growth to an extent (Butler International, 2008)."

- *Labor shortage.* A lack of qualified technical labor and experienced executives for both military depots and private firms has increased worker wages and decreased productivity. "The challenges are recruiting top management, filling the floor with experienced mechanics and managing the shrinking customer base (Edmunds, 2008)."

- *Consolidation.* Consolidation by military depots (BRAC) and private firms is primarily conducted to improve the competitive environment within which they operate and to create efficiencies across the supply

[4] Independent MROs do not have the same overhead cost structure as in-house and OEMs, therefore, are able to offer lower prices. They also compete in niche markets that in-house and OEMs are unable or unwilling to compete in, creating greater value to their customers.

chain. The global nature of the industry has many seeking consolidation opportunities (Edmunds, 2008); "ensuring compliance and adherence to the rules is not simple or standardized. Consolidation will enable the top tier MROs to offer more closely aligned practices of rules enforcement" (Edmunds, 2008).

D. FUTURE MARKET FORECAST

- *Commercial*. The global commercial airline inventory is projected to grow at a rate of 4.6 percent between 2008 and 2018. This represents an increase of over 10,000 aircraft to the global fleet (Doan, 2008). During this same period the commercial AMRO market is forecasted to grow at a rate of 4.3 percent, from $45.1 billion to $68.6 billion.

- *Military*. The global military aircraft inventory is projected to decline from approximately 39,000 aircraft in 2008 to below 38,000 aircraft by 2018. These totals include new deliveries and the loss of retired aircraft (Chrisman, 2008). During this same period the global military AMRO market is forecasted to grow from $60.7 billion to nearly $65 billion; much of this growth is attributed to increased cost of maintenance on existing, mature aircraft (Jackman, 2005).

E. INDUSTRY SUMMARY

Competing in the AMRO Industry requires both military depots and private firms to continuously analyze the external environment within which they operate. Both military and commercial markets are heavily influenced by factors beyond their control: political decisions (military) and the health of the airline industry (commercial). Both markets are projected to grow steadily over the next decade but the recent global credit crises will influence both commercial AMRO spending, the deployment of military aircraft, and the subsequent maintenance to those aircraft. These factors, discussed in detail in the following chapters, necessitate the need for FRCSW to strategically plan for the long-term viability in the military AMRO industry.

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III. AVIATION MAINTENANCE IN THE U.S. NAVY

A. THE TRADITIONAL THREE LEVELS OF MAINTENANCE[5]

The organizational, intermediate, and depot levels of aviation maintenance are distinctive in organization, mission and concept. Listed below is a brief synopsis of each level's responsibility to the Naval Aviation Maintenance Program.

1. Organizational

Organizational level (O-level) is performed by an operating unit on a day-to-day basis in support of its own operations. The O-level's maintenance mission is to maintain assigned aircraft and aeronautical equipment in a Full Mission Capable (FMC) status while continually improving the local maintenance processes. While O-level maintenance may be done by intermediate (I-level) or depot level (D-level) activities, O-level maintenance is usually accomplished by maintenance personnel assigned to aircraft reporting custodians (Commander Naval Air Forces, 2009). Aircraft-reporting custodians are responsible for the administrative reporting and maintenance of weapons systems in their custody. Squadrons, such as, VFA-34, VF-101, HM-14, HSC-26 are examples of O-level activities (or units). These O-level activities are assigned aircraft, equipment, and personnel that provide direct support to the warfighter. These maintenance functions generally are grouped under the categories of inspections, servicing, handling, on-equipment repairs, preventive maintenance, and upkeep (Commander Naval Air Forces, 2009).

2. Intermediate

The I-level's mission is to enhance and sustain the combat readiness and mission capability of supported activities by providing quality and timely material support at the nearest location with the lowest practical resource expenditure (Commander Naval Air Forces, 2009). I-level maintenance consists of on- and off-equipment material support.

[5] Section A with minor modification is drawn directly from, F. R. Clemmons and, H. M. Falconieri, "Analysis of Fleet Readiness Center Southwest Concept Integration: New-Employee Orientation and Communications Process," (MBA Project, Naval Postgraduate School, 2007), 3-4.

On-equipment maintenance is conducted on the aircraft/end-item. On-equipment maintenance includes the repair of installed engines, calibration of systems, or repair of support equipment. Off-equipment maintenance is conducted when the component/item is removed from the aircraft/end item and repaired at the facility. Off-equipment maintenance includes the processing of aircraft components; incorporation of technical directives; provision of technical assistance; the manufacture of selected components, liquids, or gases; and performance of certain on-equipment repairs (Commander Naval Air Forces, 2009).

3. Depot

The D-level's maintenance is performed at or by the Naval aviation industrial establishment to ensure continued flying integrity of airframes and flight systems during subsequent operational service periods. D-level maintenance is also performed on material requiring major overhaul of parts, assemblies, sub-assemblies, and end-items beyond the capability of I-level. D-level maintenance includes manufacturing parts, modifying, testing, inspecting, sampling, and reclamation (Commander Naval Air Forces, 2009). D-level maintenance supports O-level and I-level maintenance by providing engineering assistance and performing maintenance beyond O-level and I-level capabilities (Commander Naval Air Forces, 2009).

B. U.S. CODE TITLE 10 PUBLIC/PRIVATE PARTNERSHIPS

In 2001, the House and Senate Armed Services Committees (HASC and SASC, respectively) determined that an effort, to compensate for the infrastructure losses caused by BRAC, needed to be undertaken. In response to the infrastructure losses the HASC and SASC instituted two additional laws in Title 10, sections 2466 and 2474. These two laws provided for the establishment of public/private partnerships for conducting depot-level repair and set forth the laws under which these partnerships would function. U.S. Code Title 10 Section 2474 establishes the precedent for Secretary of Defense approval of public/private joint ventures and Section 2466 establishes the limitations on the amount of funds that can be contracted to private firms. The following section will

explore these two laws, discuss the impetus for their inception, how the laws are being implemented, and finally discuss current problems these joint ventures are experiencing.

1. Application of the Law

The formulation of the laws relating to public/private partnerships and the limitation of private maintenance contracting in 2001 were in response to the efforts, over the previous 13 years, of Congress to dramatically reduce the number of military bases through BRAC. BRAC is a joint effort between DoD and Congress to close excess military installations with the purpose of saving money, aligning the current defense goals with the force structure and maximizing efficiency. A complicating issue resulting from the closure of these bases was the loss of manufacturing, maintenance and depot-level repair facilities. Force structures can be realigned and military units reassigned; however, difficulties exist in replacing the loss of civilian technicians who have the expertise, knowledge and skills necessary to conduct repairs to highly technical military equipment (Holman, Denman, Epstein, Knoepfle, Waytel, & Newton, 1998).

In an effort to compensate for the loss of military industrial capabilities and technical expertise, while at the same time creating private-sector jobs for the highly skilled civilian technicians released under BRAC, the U.S. Congress added Section 2474 to Title 10. Section 2474 stipulates that the Secretary of Defense "shall designate each depot-level activity of the military departments and the Defense Agencies…as a Center of Industrial and Technical Excellence (CITE) in the recognized core competencies of the designee" (U.S. House of Representatives, 2008). A CITE is defined as a maintenance facility that provides the military with a means of conducting depot-level repairs on implements directly related to the core competencies of each individual branch (U.S. House of Representatives, 2008). A core competency is defined as the "capabilities necessary to enable the Armed Forces to fulfill the strategic and contingency plans prepared by the Joint chiefs of Staff and for which the Military Departments believe the DoD should be a recognized leader in the national technology and industrial base" (Under Secretary of Defense for Acquisitions Technology and Logisitics , 2007). For example, Fleet Readiness Center Southwest in San Diego is designated as a CITE due to

its capability to conduct maintenance, repair and overhaul on naval aircraft, an implement in executing the Naval core competency of projection of power from the seas. In short, the purpose of the redesignation is additional focus on both best-business practices and core competencies through the encouragement of public/private partnerships (U.S. Army Materiel Command, 2004). The designation of CITEs attempts to reduce overall government expenditure on capital resources while maintaining the necessary industrial base to effect depot-level repairs.

The law provides a mechanism for depots both to solicit and outsource work through the use of contracts with private firms. The more common is outsourcing, to private firms, additional work that a depot either does not have the capability to perform or does not have the capacity to conduct at the present time (Hunter, 2006). However, the law also allows DoD depots to manufacture military-related goods for distribution to private firms. The law stipulates that goods sold in this manner must be utilized for direct military application. In effect, this law provides a means for private firms to bid for depot-level repair work as needed by DoD, and DoD to bid for work from private firms that fall within their core competencies. This application is articulated further in the MATCOM Depot-Level Maintenance Program for the Marine Corps in the following manner: "Partnerships can range from joint public-private undertakings, to private sector participation in some aspect of DoD depot maintenance production, to direct sales of articles or services to the private sector, or to leasing of DoD facilities or equipment" (U.S. Marine Corps Material Command, 2004). Under this interpretation, it is feasible for a command to engage private sector participants in any portion of DoD depot-level maintenance as both an outsourcing partner and a source for additional work to fill capacity.

U.S. Code Title 10 articulates the intentions of Congress to more fully utilize CITEs while encouraging private funding. The law directs a series of six expectations from this program: 1) encourage the private usage of the government workforce to ensure an adequate industrial base and work force exists to meet the needs of the armed forces, 2) maximize utilization of CITE capacities, 3) lower maintenance overhead costs, 4) encourage private sector investments in joint ventures and recapitalization, 5) lower cost

of DoD maintenance, and 6) increase cooperation between private and DoD industry (U.S. House of Representatives, 2008). The application of these expectations was assigned to the Secretary of Defense (SECDEF) to both select and designate CITEs, and then implement the public/private programs that will supplement the CITEs. This authority was delegated to the Service Secretaries to assess each branch's core competencies and provide the Secretary of Defense (SECDEF) with a list of industrial centers providing the essential depot repair capabilities to service these core competencies. The CITE designation process was initiated in 2001 but has been in constant revision ever since (Secretary of the Navy, 2002).

The establishment of private/public partnerships is handled on a case by case basis with each individual partnership requiring the formulation of a business case analysis detailing the advantages gained by both parties (Hunter, 2006). The development of a business case is an endeavor requiring 18 to 36 months of manpower and logistical support to ensure that all portions of the intended agreement are clearly articulated and that each side understands the limitations of the partnership (Hunter, 2006). Business case development includes, but is not limited to, a discussion of expected performance, producibility, reliability, maintainability, and supportability enhancements (Defense Acquisiton University, 2009). The process is similar to the writing of a contract and is guided by instructions covering Performance Based Logistics (Defense Acquisiton University, 2009). The completed business case analysis is then submitted to a Systems Command (SYSCOM) level official (Flag/Senior Executive Service) for approval. Following the review by the SYSCOM, the business case analysis is then reviewed by the comptroller and a letter of approval is forwarded to the Assistant Secretary of the Navy for Research Development and Acquisitions (ASNRD&A) (Secretary of the Navy, 2002). This process has created numerous inefficiencies discussed further in following sections.

2. Fifty Percent Law

U.S. Code Title 10 Section 2474 creates the possibility of the military outsourcing a significant portion of its depot repairs to private firms if those civilian depots can

conduct the maintenance at a lower cost and similar quality as their military counterparts. In anticipation of this issue, Congress instituted Section 2466 of Title 10 which provides for the commonly referred to "50 Percent Law." Section 2466 stipulates that "Not more than 50 percent of the funds made available in a fiscal year to a military department or a Defense Agency for depot-level maintenance and repair workload may be used to contract for the performance by non-Federal Government personnel of such workload for the military department or the Defense Agency" (U.S. House of Representatives, 2008).

In practice, this provides the military with an opportunity to outsource either all or a portion of the repairs on a specific piece of equipment. The requirement stipulates only that at least 50 percent of DoD depot-level maintenance funding be spent at the military depots. The SECDEF is required to report the percentages of expenditure for depot-level repairs to Congress on 1 August each year (U.S. House of Representatives, 2008).

Examples of successful partnerships existed prior to the adoption of sections 2474 and 2466 of Title 10 including the M1 Recuperator Facility Use at Anniston by Honeywell (Lease under 10 U.S.C. 4543) and the Firefinder Block II Program at Tobyhanna with Raytheon (Sale of services under 10 U.S.C. 2208(j)) (Hunter, 2006). These partnerships, however, fell under various specific Title 10 codes, as indicated above, and required specific congressional consent in Title 10 to exist. The adoption of sections 2474 and 2466 allow these partnerships to be developed and approved within DoD, only requiring that they meet the applicable statutes contained within these sections. Partnerships existing prior to the institution of sections 2474 and 2466 are included in the private portion of the 50 Percent Law (Hunter, 2006).

Partnerships developed that are non-statutory and now exist under sections 2474 and 2466 include: "the M1/M1A2 Upgrade at Anniston Army Depot with General Dynamics and the Multiple Launch Rocket System M270A1 at Red River with Lockheed Martin" (U.S. Army Materiel Command, 2004). A partnership that outsources all repairs is usually associated with new items in the inventory, where the government maintenance depots have yet to integrate the necessary repair capabilities and the private production

firm has those capabilities. An example of this is the case of General Dynamics conducting all Stryker refurbishments until Anniston Army Depot was able to get necessary support equipment on line (Hunter, 2006).

An analysis of FY 2004 public/private partnerships by service is detailed in the graphic below.

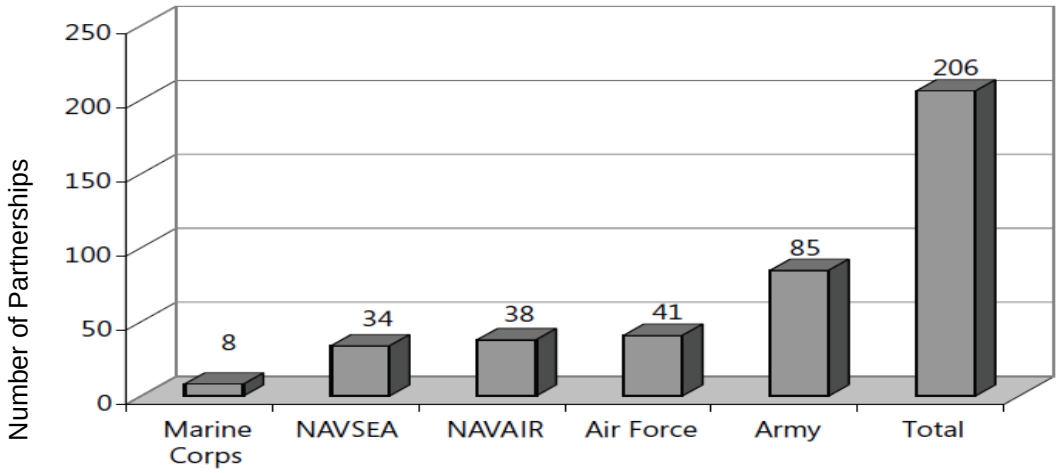

Figure 3. Fiscal Year 2004 and Earlier Public-Private Partnerships by Service (From: Hunter, 2006)

The Army, in effort to further the success of these partnerships, has conducted an assessment of the best practices from the other services and has determined that: "the most effective partnerships are those that focus on enhancing performance of the supply chain while driving down costs" (U.S. Army Materiel Command, 2004).

3. Problems with Public/Private Partnerships

In an effort to understand the key success factors and assess the effectiveness of a fully-integrated CITE, Congress required, under House Conference Report 110-447 (2007), that DoD and the Government Accountability Office (GAO) conduct an expansive analysis of public/private partnerships and their implementation at CITEs (Solis, 2008). The HASC and SASC requested six items be specifically researched: 1) approaches to partnership implementation, 2) standardized cost and reimbursement guidance for partnerships, 3) procedures for completing partnership contracts within 12 months, 4) SECDEF's use of commercial practices in partnerships, 5) delegation of

authority to allow changes in partnerships that do not affect safety, form, fit or function of the equipment and 6) plans to expand core capabilities through use of CITEs (Solis, 2008). The thrust of this assessment was to ensure a standardized approach was taken in the set up, administration and evaluation of partnerships at the CITEs. In the assessment, it was clear that item 3) was believed to be unworkable and that the placement of a 12-month restriction on contract negotiations would be detrimental to the process (Solis, 2008). This accentuates one of the key issues with public/private partnerships, the time and resources required to establish the partnerships. Due to the detail required in establishing the relationship and determining the necessary compensation methods, these relationships can take upwards of two to four years to establish (Solis, 2008).

The second major issue found by DoD and GAO was the lack of standardized metrics to measure the success or failure of a partnership (Solis, 2008). The DoD, as of July 2008, has not standardized any form of metrics even within a particular branch (Solis, 2008). The current methodology used assesses each partnership on a case by case basis in much the same way as each case first is approved. The standardization of both the application process and the assessment process would facilitate the desired process required by Congress. The issue with this approach is the spectrum over which these partnerships can spread. They can include public/private partners working in the same facility, partners sharing resources, completely outsourcing a segment of work to a partner, or outsourcing entire equipment lines to a partner. The standardization while creating an optimal solution would also create restrictions on the possibilities to which the CITEs can utilize these partnerships (Solis, 2008). DoD further believes it already has a working process in use that examines the stated goals of the partnership and evaluates the performance of the partnership based upon those goals (Solis, 2008).

The implementation of the CITE program and the expansion of public/private partnerships is designed to allow DoD to manage depot-level maintenance in a more fiscally-responsible and rapid fashion. In 2004, the private partners accounted for only 2.2% of the $25.4 billion dollars of work performed; however, that figure is growing every year (Hunter, 2006).

IV. EXTERNAL FORCES ON THE INDUSTRY

A. INTRODUCTION TO PORTER'S FIVE FORCES[6]

Describing the external forces on the industry begins by defining the overarching industry structure through an examination of the five-forces of competition acting on the industry. These five forces were defined by Michael Porter, in his book *Competitive Strategy*, as: 1) threat of new entrants, 2) rivalry among existing competitors, 3) threat of substitute products, 4) bargaining power of the consumer, and 5) bargaining power of the suppliers. These forces interact with one another as shown in Figure 4.

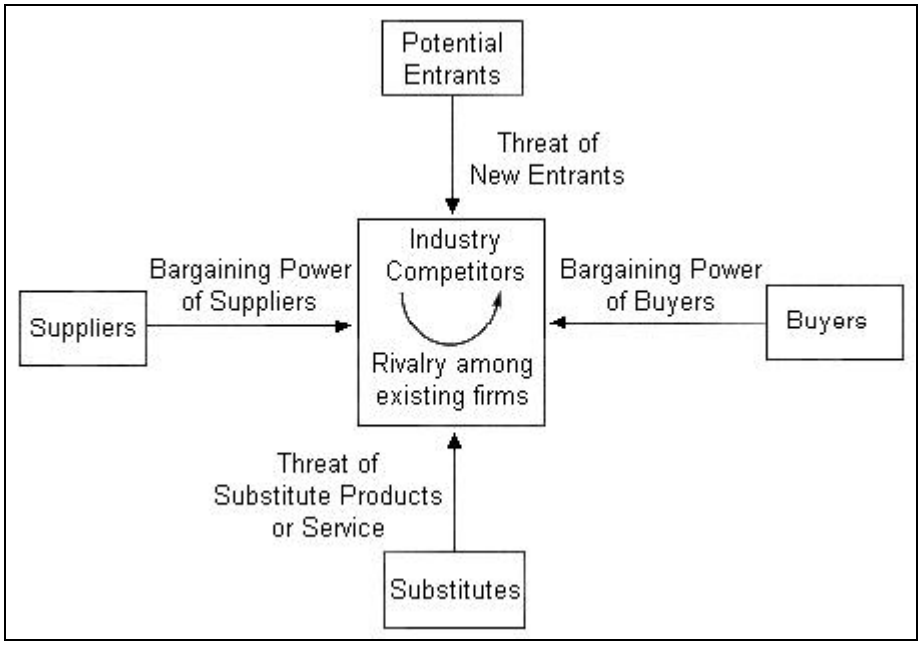

Figure 4. Forces Driving Industry Competition (From: Porter, 1980)

The more clearly-defined the industry within which the firm competes, the more accurately the forces of competition can be identified and analyzed. While narrowing the focus of the analysis is critical; it is also critical to ensure all sectors of the firm's operations are represented in the analysis. If the firm operates in multiple distinct industries or markets, it may be necessary to conduct multiple analyses on these different

[6] Contents of Section A are summarized from Chapter I of *Competitive Strategy* by Michael Porter.

sectors. The military AMRO industry is segmented into four distinct markets: 1) field maintenance, 2) components, 3) engines and 4) airframes. FRCSW competes in each of these segments, therefore, separate analysis for each segment is required.[7]

The development of a military AMRO industry five-forces analysis is critical in providing FRCSW with the competitive boundaries within which they operate. Determining the competitive boundaries allows the firm to gauge the intensity of the competition and anticipate the direction from which this competition may come. "The collective strength of these forces determines the ultimate profit potential in the industry, where profit potential is measured in terms of long-term return on invested capital" (Porter, 1980). To become a competitor within the military AMRO industry, a firm requires extensive long-term capital investment, thus making long-term return on the investment a critical feature of competition. Although FRCSW operates as a not-for-profit competitor in the military AMRO industry, the Navy Working Capital Fund and U.S.C. Title 10 combine to create an environment within which profit-seeking firms and FRCSW compete for business.

B. THREAT OF NEW ENTRANTS

The threat of new entrants is the threat posed to the established industry competitors by new firms entering either through acquisition or startup. Acquisition firms enter the market either by purchasing a current competitor and rapidly expanding that firm's market share, or by purchasing multiple firms and creating a powerful conglomerate. Startup firms enter the market with large sums of investment capital and are can easily capture and exploit the latest military aircraft technology developments. These firms typically bring new technologies or improved techniques to the industry that may alter the current competitive environment. Startups and conglomerates experience several barriers to entry that must be overcome to establish successful firms.

[7] "Uniform personnel perform at least 80 percent of field maintenance" (Tegtmeier, 2006), therefore, the field maintenance segment will not be assessed.

The seven barriers to entry are: 1) economies of scale, 2) product differentiation, 3) capital requirements, 4) switching costs, 5) access to distribution channels, 6) cost disadvantages independent of scale and 7) government policy (Porter, 1980).

1. Economies of scale represent the cost advantage per unit experienced by firms with high volume; this advantage is highly dependent upon variable cost per unit. "Economies of scale deter entry by forcing the entrant to come in at large scale and risk strong reaction from existing firms or come in at a small scale and accept a cost disadvantage, both undesirable options" (Porter, 1980).
2. Product differentiation examines the barrier to entry that requires startup firms to create brand recognition and make a distinction between a startup's new products and an existing firm's offerings.
3. Capital requirements are those barriers that represent large initial investment in facilities, workforce, initial advertising, research and development and equipment.
4. Switching costs represent the costs imposed upon customers by changing suppliers; these include retraining of employees in the new firm's procedural requirements, geographic constraints that impose additional costs and rebuilding of business relationships.
5. Access to distribution channels examines the complex relationships between the web of suppliers and the new entrant, as well as the network required to distribute products to customers.
6. Cost disadvantages independent of scale represent the advantages enjoyed by established firms in the industry that are independent of repair volume, and could include advantages to established firms that new entrants are unable to reproduce.
7. Restrictions imposed by government policy examine the limits placed on firms by resident laws and codes.

The following assessment is based upon a compilation of the analysis conducted on the seven barriers to entry that follow.[8]

1. Economies of Scale

- **All** – Due to the size of the military aircraft industry, a world-wide aircraft inventory of 39,113 in 2008, the advantages of economies of scale are limited in all military AMRO segments (Chrisman, 2008). Limited economies of scale increase barriers to entry.
- **Component** – New entrants into components that are dual-use, having both military and civilian applications, can experience an economy of scale; however, products of this type are a fairly limited portion of the component segment. New entrants that can leverage economies of scale by utilizing dual-use components can decrease their barriers to entry (Armstrong, 2005) (KPMG, 2003).
- **Engine –** The engine segment has significant participation by both OEMs and Independents, making it an industry segment with open opportunities. Governments control only 43 percent of the segment's market share, leaving the remaining 57 percent for OEMs and Independents (Stewart, 2005). In the U.S. market the involvement of private firms is reduced, with the military AMRO depots controlling 75 percent of the engine maintenance activity; however, large European Air Forces receive a majority of their maintenance through OEMs or Independents (Stewart, 2005). New entrants could leverage the success of European engine MRO firms to increase the privatization in U.S. markets, thereby decreasing the barriers to entry.

[8] The following analysis applies to the segments listed in bold prior to the explanations.

2. Product Differentiation

- **Airframe/Engine** – Bundling of service and sales by OEMs provides these OEMs with a position of increased strength, as they are able to provide discounts to customers on original purchases when made with an accompanying service contract (Carpenter & Henderson, 2008). The ability of OEMs to bundle sales and services increases the barriers to entry for new firms.

- **Component/Engine** – The advent of the FAA's Parts Manufacturer Approval (PMA) process allows non-OEMs to reverse-engineer some OEM parts and sell them at a significant discount (Carpenter & Henderson, 2008). PMA parts are gaining wider acceptance, thereby decreasing the barrier to entry for PMA parts manufacturers.

- **All –** Low-cost competition utilizing PMAs is one of the primary methods for a new entrant to differentiate themselves and gain entry into government contracting. Established firms enjoy some recognition but are subject to being undercut by new entrants utilizing PMAs in future contracts, due to the cost/quality competition standards (Solis, 2008). Low product cost presents one method of decreasing the barriers to entry.

3. Capital Requirement

- **All –** Facilities for heavy industry-crafted components, (i.e., landing gear, hydraulics equipment, engines and airframes) require significant capital investments for new entrants (Carpenter & Henderson, 2008). FRCSW occupies more than 80 buildings and over 2.6 million square feet of production area to conduct military AMRO maintenance (Kelly, 2008). High capital investment requirements lead to increased barriers to entry.

- **All –** Specialized equipment for highly technical repairs and testing (electronics, avionics and engines) requires large capital investments by new entrants (Carpenter & Henderson, 2008). High capital investment requirements lead to increased barriers to entry.
- **All –** Operating capital is required to attract the high-quality skilled workers necessary for military AMRO. Most workers in the military AMRO industry are members of unions or trade organizations that command high pay and compensation packages costing in excess of $80 per maintenance hour (Sanyal, 2009). High operating capital requirements lead to increased barriers to entry. Relationships with these Unions are discussed further in bargaining power of suppliers.
- **All –** Establishment and maintenance of industry certifications such as ISO 9000 and AS9100 require large initial capital investments in manpower, training and equipment (Kelly, 2008). Startup firms are more heavily exposed to these initial costs than conglomerates. Rigorous industry certification processes present increased barriers to entry.
- **Airframe –** Due to a decade of difficult economic times for the commercial airline industry (post-9/11 and the global credit crunch), commercial ARMO firms have consolidated operations leaving available hangar space near large airports for new entrants (Berger, 2005) (Marcontell, 2009). This available hangar space could be obtained by new entrants at bargain prices, thereby decreasing barriers to entry.

4. Switching Cost

- **All –** Due to the complexity and number of specialized airframes and components, switching to new suppliers can represent significant costs to the customer (Michaels, 2008). High switching costs increase barriers to entry.

- **All –** Government contracts are rewarded based upon a compilation of data about the competing firms. This compilation includes the assessment of risk attributed to each competitor (General Services Administration Department of Defence, 2009). Startup firms pose greater risk than established firms, therefore, with all other aspects of the contract held even the government will choose the lower risk firm, increasing the barrier to entry. It should be noted that U.S. DoD depots do not require any contracts to perform MRO work on U.S. DoD aircraft (Kelly, 2008).
- **All –** Government contracts often are let to large prime contractors that utilize multiple sub-contractors to complete the obligation. Competition among sub-contractors does not carry the same risk analysis requirement by the government; however, the prime will perform its own assessments (General Services Administration Department of Defence, 2009). This presents an opportunity for new entrants to establish the necessary credentials, thereby possibly lowering the barrier to entry.

5. Access to Distribution

- **All –** Due to the size, scope and intricacies involved in integrating civilian and military systems, new entrants experience challenges in establishing the necessary administrative functions to support military logistical requirements (Kovacic & Schooner, 2005). These difficulties present increased barriers to new entrants.
- **All –** Certain sensitive components require quality assurance documentation that enables the end user to track component issues back to the original repair facility and that facility's supply chain (Commander Naval Air Forces, 2009). Maintenance of the required database on these components can create additional expenses for new entrants, increasing the barriers to entry.

- **All –** Necessary shipping procedures for handling classified and sensitive material expose new entrants to additional training and equipment costs. Obtaining security clearances can cost up to $3,700 per clearance needed (Farrell, 2008). These additional expenses can increase the barriers to entry.

6. Cost Disadvantages Independent of Scale

- **All –** Access to OEM documentation and technical expertise necessary to effect repairs requires new entrants to establish both business and working relationships with these OEMs (Carpenter & Henderson, 2008). The information necessary to conduct repairs often is proprietary and requires licensing to access. The cost of licensing access increases the barriers to entry.
- **All –** For firms to remain competitive in the aerospace industry, they are required to obtain and maintain AS9100 certification. This certifies that parts and maintenance done by these firms meet the minimum qualifications required for aerospace suppliers (Society for Automotive Engineers, 2007). Investments required to obtain industry certifications increase the barriers to entry.
- **All –** New entrants must establish the necessary work force with security clearances that will allow for work on classified and sensitive components (Secretary of the Navy, 2006). Obtaining these security clearances is a lengthy and expensive process requiring interaction with multiple government agencies (Farrell, 2008). The cost of obtaining initial security clearances increases the barriers to entry.
- **All –** Due to the nature of the equipment repairs and the possible impact on national security, repair facilities may require extensive physical security to safeguard government equipment (Chandler, 2005). Increased physical security costs create increased barriers to entry.

7. Government Policies

- **All –** As discussed in Chapter III, U.S.C. Title 10 requires that military depots maintain at least 50 percent of the depot maintenance work to ensure the retention of core competencies. As more firms enter the AMRO industry, and industry forecasts predict slow growth (less than 2 percent), competition for the available work will increase (Chrisman, 2008). Greater competition for available work increases barriers to entry.
- **All –** Many government contracts are let on a lifecycle basis and firms receiving these contracts retain the right to repair work on certain components throughout the life of the airframe program (General Services Administration Department of Defence, 2009). Existence of lifecycle maintenance contracts decreases the number of available contracts and, therefore, increases barriers to entry.

New entrants into the military AMRO industry experience a wide variety of barriers to entry. Successful firms find a niche market, or create cooperative alliances with other small AMRO firms to begin operations, working to expand market share over time (Butler International, 2008) (Michaels, 2008). Opportunities also exist for commercial AMROs experiencing declining market share due to decreased commercial airline activity; these AMROs can seek entry into the military AMRO market as a way to leverage idle resources for additional profit opportunities (Magalhaes, 2004). Although the threat of new entry exists, "Players in the aerospace and defense market are becoming increasingly large integrated multinational companies" (Datamonitor, 2008).

C. RIVALRY AMONG EXISTING COMPETITORS

Rivalry among existing competitors is the threat posed to the industry by increasing competition between existing firms. "Rivalry occurs because one or more competitors either feels the pressure or sees the opportunity to improve position" (Porter, 1980). In the military AMRO industry, like many other industries, outsourcing has become key to firms increasing their competitive position by concentrating on their core competencies and divesting non-profitable interests (Stewart, 2005). Due to the

requirements of U.S.C. Title 10, military depots, who in the past were the exclusive suppliers of depot level repairs to the DoD aviation enterprise, now must compete with commercial firms and each other. The opening of competition to independent commercial firms is designed to create a downward pressure on military MRO prices, thereby benefiting the DoD as a whole. Individual military depots, in an effort to remain competitive, have instituted AMRO practices such as Theory of Constraints, LEAN and Six Sigma. The following paragraphs examine the forces applied on the military AMRO industry segments by the rivalry among existing competitors.

Porter defines the rivalry among competitors as a compilation of many factors; not all factors apply in every industry. These factors are the balance of competition, rate of industry growth, fixed costs, differentiation or switching costs, ability to adjust for changes in capacity, diversity of competitors, strategic interest of competitors, exit barriers and changes in factors defining the rivalry (Porter, 1980). Assessment of the balance of competition examines the volatility of the rivalry due to firms attempting to create a competitive advantage. Assessment of the rate-of-industry growth examines how firms adjust to capture the limited market share available as an industry matures. Assessment of fixed costs examines what adjustments are made by rivals to ensure they maintain operations at capacity. Assessment of differentiation or switching costs examines the loyalty of consumers of the industry to specific brands or firms. Assessment of the ability of firms to adjust for changes in capacity examines how dependant firms in the industry are on maintaining high volumes of production. Assessment of diversity of competitors examines how commonality of backgrounds and executive personalities affects the industry. Assessment of competitor's strategic interest examines how critical this industry is to a firm active in multiple industries. Assessment of exit barriers examines the economic, strategic, or personal factors preventing a firm from exiting the industry. Assessment of the changes defining the rivalry examines how changes at one firm in the industry can rapidly change the competitive environment for industry.

Assessment of the rivalry forces in the military AMRO industry is based upon a compilation of the analysis conducted on each of the segments that follow. Component and engine segments have similarities in the way in which rivalry affects competitors; therefore, their analysis is combined into one section.

1. Engine and Component

- These segments are populated with various firms, from small single focus businesses to large conglomerates who supply components and engines as a small portion of their firm's offerings (Berger, 2005). Unbalanced, diverse, and highly populated industries decrease rivalry forces.
- The military AMRO component and engine segments are projected to grow 10.4 percent and 9.6 percent, respectively, by 2018 (Doan, 2008). High industry growth rates decrease rivalry forces.
- Low switching costs in the component sector are experienced only in the high volume commodities; lower volume, highly-specialized components impart extensive switching costs to the consumer and decrease rivalry forces (Butler International, 2008).
- Depending upon the volume and specialization of the particular component, firms may or may not experience high exit barriers (Butler International, 2008). Greater technical specialization combined with high initial capital investments in equipment and facilities can create high exit barriers, thereby increasing rivalry forces.

2. Airframe

- In the United States, where more than 70 percent of the airframe MRO is done by DoD air depots, the segment of airframe maintenance available for competition is small, with OEMs carrying the bulk of the available contracts (Stewart, 2005). Lack of similarly-sized competitors decreases rivalry forces.

- Due to the nature of airframe MRO, expansive investment in initial capital creates high exit barriers, which could lead to firms engaging in price wars in effort to remain viable (Hemmati, Randell, Monk, & Pettigrew, 2008). High exit barriers increase rivalry forces.
- Many airframes, particularly fighters and special mission aircraft, require specialized airframe maintenance only available at specific sites, usually government sites, creating high or unavailable switching costs (Stewart, 2005). Switching costs are unavailable when government laws and regulations prevent private depots from conducting repairs. High switching costs lead to decreasing rivalry forces.
- Some government-owned depots were built with excess capacity, providing these depots with the opportunity to draw additional work when not required for surge operation support (Choo, 2004). This increases rivalry forces between government-owned depots, especially due to recent BRAC events.

Threats from rivals in the military AMRO industry come both from privately-owned firms, and other government depots. BRAC 2005 consolidated depot maintenance in all branches of the military in effort to expedite 2001 revisions to U.S.C. Title 10 allowing for increased private competition in military AMRO. Increasing pressure from the DoD budget and Congress could lead to more extensive outsourcing of military AMRO work to private firms and further consolidation of government depots (Stewart, 2005). As the opportunity for improved market position in the military AMRO industry presents itself to private firms, the rivalry forces in the marketplace will increase (Porter, 1980).

D. THREAT OF SUBSTITUTE PRODUCTS

The threat of substitute products describes those products outside the industry that have the ability to perform the same or similar function as the industry's current offerings. "Substitutes limit the potential returns of an industry by placing a ceiling on the prices firms in the industry can profitably charge" (Porter, 1980). The current power

projected by military aircraft on the battlefield makes them essential for any military action. The continued employment of military aircraft is dependent upon maintenance support for these aircraft. Continued operation of any aircraft requires extensive maintenance; the military aviation enterprises conduct this maintenance based upon flight hours (Commander Naval Air Forces, 2009). Therefore, as long as aircraft continue to fly, maintenance on these aircraft will be required, making AMRO an irreplaceable feature of aviation enterprises. The following paragraphs examine the threat that substitute products pose to the military aviation enterprise as a whole and, thereby, the military AMRO industry.

All segments of military AMRO are presented with similar substitution threats; therefore, the following analysis applies to all segments.

- The advent and success of Unmanned Aerial Vehicles (UAVs) have led to UAVs replacing some of the mission sets of manned aircraft. UAVs typically cost ~$3–$4 million per copy (Global Security, 2007) while an F/A-18 E/F typically costs ~$57 million per copy (NAVAIRSYSCOM, 2009). While a UAV cannot perform all the mission sets required of the F/A-18, it can perform some of them, and at a significant cost advantage in not only initial purchase cost but in operations and maintenance. With UAVs being less expensive, they are more expendable and could reduce the need for MRO and thus increase the threat of substitute products.
- New airframes are designed with lifecycle cost considerations in mind, and the attempt to decrease maintenance requirements is paramount in the engineering process (Stewart, 2005). New lower-maintenance engineering of aircraft could present a reduction of the current high cost of maintaining legacy aircraft. While not a complete substitution to AMRO, the introduction of lifecycle engineering could reduce the amount of AMRO required, thereby increasing the threat of substitute products.
- The development of new technology, such as jet propulsion over propeller propulsion, can create threats of substitution within the industry.

There are no direct substitute products/services for military AMRO; however, the introduction of new technology or the assessment of a new need may lead DoD to acquire substitute products for the current aviation enterprise. Introduction of substitute products in the aviation enterprise would require military AMRO depots to adjust their offerings to provide services for the new substitute products. An example of this adjustment is seen in the development and expanding use of UAVs on the battlefield. While it is yet undecided if UAVs provide significant cost savings in the acquisition process or in operations, it is generally accepted that there will be savings in maintenance costs (Bone & Bolkcom, 2003). Increased maintenance savings through extensive use of UAVs or through decreased flight hours for manned aircraft increase the substitute pressure on the military AMRO market.

E. BARGAINING POWER OF THE CONSUMER

The bargaining power of the consumer is the control exercised over the competitors in the industry by the actions of the consumers. "The power of each of the industry's important buyer groups depends on a number of characteristics of its market situation, and on the relative importance of its purchases from the industry compared with its overall business" (Porter, 1980). Porter explains that consumers hold significant power over an industry if they are: 1) concentrated, 2) their purchases represent a significant fraction of buyer's costs, 3) the products purchased from the industry are standard/undifferentiated, 4) switching costs are low, 5) profits are low, 6) a credible threat to backward integration exist, 7) industry quality is unimportant to the consumers' product/services or 8) the buyer has full information about the seller's industry. Consumers in the military AMRO industry are defined as U.S. and foreign military aviation enterprises and the private AMRO industry via public private partnerships. The following paragraphs examine the forces applied on the military AMRO industry segments by the bargaining power of the consumer.

Bargaining power of consumers is similar throughout all segments of military AMRO; however, certain segments experience this to slightly different degrees.

- By their nature, military AMRO services are purchased by government military aviation enterprises, leading to a concentrated and integrated customer base which exerts increased customer bargaining power over the industry (Stewart, 2005).
- Military aviation enterprises have few options for maintenance; however, this has occurred because these enterprises have backward integrated into the military AMRO market. Recent Title 10 changes have lessened this affect and have fostered a more competitive environment; however, backward integration into the AMRO industry continues to increase the bargaining power of the military aviation enterprises over the depots (Stewart, 2005).
- Operations, maintenance and personnel account for over 70 percent of the global defense budget. The U.S. military spent $24.3 billion, out of a $379.9 billion defense budget, on aircraft maintenance in 2004 (Stewart, 2005). Due to the proportion of DoD funds spent on AMRO, the industry represents a significant fraction of the DoD aviation enterprise's purchases. Consumers who spend a large fraction of their budget on a single industry, military AMRO in this case, have increased bargaining power over that industry due to the customer's price sensitivity.
- The AMRO industry requires high levels of quality to be maintained in all maintenance actions due to the risk to pilots and crew of the aircraft (Commander Naval Air Forces, 2009) (Kelly, 2008). These increased requirements for quality decrease the bargaining power of the military aviation enterprise; however, this industry is large, and quality is enforced through the application of industry standards and government regulations, mitigating the loss of consumer power (Commander Naval Air Forces, 2009).

- Military aviation enterprises set the standards required for maintenance on their aircraft and require full disclosure of all expenditures; thereby giving them full information and increased bargaining power (Commander Naval Air Forces, 2009) (General Services Administration Department of Defence, 2009).

Consumers in the military AMRO market are concentrated, integrated, have full knowledge and a significant portion of their budgets invested in the industry; thereby increasing the bargaining power of military aviation enterprises.

F. BARGAINING POWER OF THE SUPPLIERS

"The conditions making suppliers powerful mirror those making buyers powerful. Suppliers can exert bargaining power over participants in an industry by threatening to raise prices or reduce the quality of purchased goods and services" (Porter, 1980). Porter explains that suppliers hold significant power over an industry if the suppliers are: 1) dominated by a few companies, 2) not obliged to compete with other substitute products to the industry, 3) the industry is not an important customer of the supplier group, 4) the supplier's product is an important input to the buyer's business, 5) the supplier group's products are differentiated or have built-up switching costs, or 6) the supplier group poses a creditable threat of forward integration. Suppliers in the AMRO industry are defined as labor, raw materials, logistics services and commodity components. The following paragraphs examine the forces applied on the military AMRO industry segments by the bargaining power of the supplier.

Bargaining power of suppliers is similar throughout all segments of military AMRO industry.[9]

- **All –** The military AMRO industry's touch labor forces are unionized; these unions are currently experiencing labor shortages and thus the industry as a whole experiences these shortages (Doan, 2008). As labor shortages continue, compensation contracts between AMROs and the

[9] The following analysis applies to the segments listed in bold prior to the explanations.

unions require increased benefit packages, thereby cutting into potential profits and raising the bargaining power of the unions (Stewart, 2005).

- **All –** Due to the specialization required for most military AMRO components, engines and airframe supplies, suppliers are unable to rapidly shift production away from military-related equipment, lowering the power of the suppliers (McGladrey Capital Markets LLC, 2009).
- **Component –** Manufacturers are entering the AMRO component industry in effort to supply components for sunsetting airframes (Stewart, 2005). Supplying components is necessary due to the reluctance of sunsetting airframe OEMs to continue supplying these parts. The military requires these components to keep the accompanying airframes available for tasking; therefore, increasing the bargaining power of component suppliers.
- **All –** As stated in U.S.C. Title 10 Sections 2466 and 2474, the availability of quality military AMRO is critical to the military's ability to maintain core competencies required for national defense. AMRO firms hold a product that is critical to the consumer's business, thereby increasing the bargaining power of the supplier.
- **All –** While U.S.C. Title 10 revisions have increased the amount of participation of private firms in the military AMRO industry, the military will retain the core competency to maintain and repair its aircraft. This prevents excessive forward integration by the suppliers into the military AMRO market, thereby limiting the bargaining power of the suppliers.

Labor concerns throughout the AMRO industry are increasing the bargaining power of unions, causing the AMRO industry to take proactive steps to mitigate these concerns. "Airframe and power plant schools are graduating fewer students from their programs, but they have modernized their facilities and are prepared to address the impending shortage of qualified technicians. MRO enterprises and OEMs are teaming up with work-study programs at aviation schools and junior colleges to meet their future

labor needs" (Frost & Sullivan Research, 2008). The bargaining power of suppliers to the military AMRO industry is decreased due to the restrictions placed on the industry by U.S.C. Title 10.

V. PEST ANALYSIS

A PEST analysis examines the macro-environment within which the firm operates by dividing the environment up into four forces: 1) Political, 2) Economic, 3) Social, and 4) Technological. The analysis focuses on those forces that a firm cannot control or greatly influence. These macro-environmental forces interact with one another, as shown in the following figure:

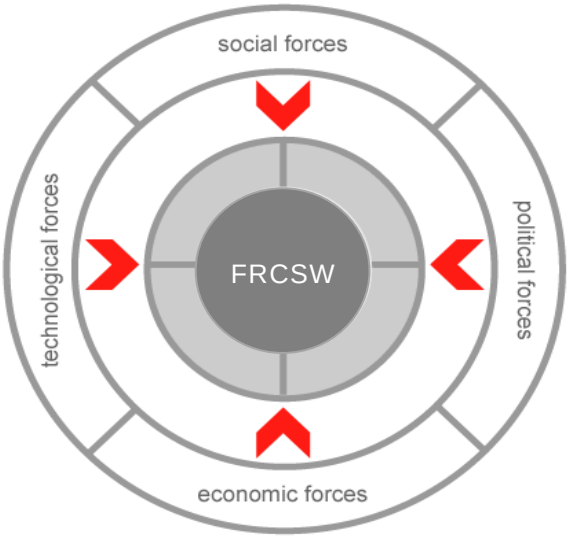

Figure 5. PEST Analysis (After: Provenmodels, 2009)

It is necessary for the firm to adapt its strategy to these environmental constraints in order to ensure continued viability. A firm developing its strategic plan will utilize the results of a PEST analysis in concert with the Porter's Five-Forces analysis to determine where opportunities and threats exist in the marketplace. A PEST analysis of the AMRO industry will reveal those macro-economic factors within which FRCSW must operate. The following Sections present those factors and a brief explanation of their impact on the AMRO market.

A. POLITICAL

Political factors refer to those government policies, laws or regulations that directly impact the market.

- *Federal Government decisions on the employment of the national military aviation enterprise.* Political decisions determine when and how the military, as a whole, will be employed and this employment has a direct impact on the MRO industry. In FRCSW's case the increase or decrease of employment of Naval Aviation around the world will directly impact the amount of repair hours required, and thereby influence the amount of work conducted at FRCSW. The current employment of aviation assets in Overseas Contingency Operations increases the amount of repair work to be completed on all aircraft in the U.S. inventory. In addition to general AMRO required by increased flight hours these operations also provide for $2.5 billion in additional work to conduct the necessary reset and reconstitution efforts prior to the aircraft's return to the normal service (Michaels, 2008).

- *Job security in the local economy.* FRCSW employs nearly 3,000 Navy civilians, 1,000 military, and 460 civilian contractors who generated over $537 million in revenue during 2007, half of which went to salaries for these employees (Kelly, 2008). Politicians representing districts containing large military installations, such as FRCSW, appreciate the economic impact of these installations. The continued security and viability of these bases directly impacts their constituents and thereby the politician's ability to be re-elected. Realignment or closure of a large facility creates an overriding concern for the officials and leads these politicians to join caucuses such as the House Military Depot and Industrial Facilities Caucus (Office of Congressman Walter B. Jones, 2009). "While the loss of jobs for DoD civilians and other adverse effects are in the short term inescapable byproducts of base closures, such effects

can continue for some time (Holman, 2001)." Political pressure is placed on these military depots to ensure they remain a critical piece of national security and thereby maintain viability.

- *Marketing Capabilities to political leaders.* After five iterations of the BRAC process, designed to reshape the military enterprise, COs of military installations are aware of the potential of future iterations of BRAC impacting their commands. In effort to ensure their command is not included on these potential future iterations of BRAC, they must develop and aggressively implement a marketing plan to sell their capabilities and military value to political leaders. Development of this plan should focus on those attributes important to previous BRAC committees such as:

  a) "Current and future mission capabilities and impact on operational readiness of the total force of the Department of Defense, including the impact on joint warfighting, training, and readiness (Wynne, 2005)."

  b) "The availability and condition of land, facilities, and associated airspace (including training areas suitable for maneuver by ground, naval, or air forces throughout a diversity of climate and terrain areas for the use of the Armed Forces in homeland defense missions) at both existing and potential receiving locations (Wynne, 2005)."

  c) "The ability to accommodate contingency, mobilization, surge, and future total force requirements at both existing and potential receiving locations to support operations and training (Wynne, 2005)."

  d) "The cost of operations and the manpower implications (Wynne, 2005)."

Consideration of such BRAC attributes should steer any future strategic plans by FRCSW.

- *Political relationships with Foreign Military Sales (FMS) nations.* FMS inventory is usually sold to foreign nations with a service contract accompanying the sale to ensure the proper servicing of these items. "Foreign military sales in fiscal year 2008 climbed to more than $36 billion (Inside Defense, 2009)." Each of these items requires significant maintenance and large portions of the $36 billion quoted above will go to these maintenance efforts (Inside Defense, 2009). U.S. DoD depots conduct much of this maintenance and loss of these contracts due to political processes could impact U.S. DoD depots.

- *HASC and SASC pressure to increase privatization of AMRO in effort to approach a 50/50 split of maintenance.* In U.S.C. Title 10 Section 2466 Congress called for increased privatization of U.S. military depot capability by instituting the 50 percent law. While the military industrial base has been slow to engage private industry the greatest progress has been seen in the engine market where 25 percent of U.S. military off-aircraft engine maintenance is outsourced (Stewart, 2005). While the majority of this outsourced maintenance is performed by OEMs and not independent engine repair facilities, increased outsourcing is moving the AMRO industry closer to the 50 percent split desired by Congress (Stewart, 2005).

- *Operations in an environmentally-sensitive location.* According to Environmental Health Perspectives, a journal produced by the National Institute of Environmental Health Sciences, California has some of the nation's strictest environmental laws (Fisher, 1996). Firms operating in California have to operate within these laws which are often more stringent than similar federal regulations. FRCSW has received numerous

environmental awareness awards, including the White House "Closing the Circle Award" for environmental accomplishments, by meeting and exceeding federal and state environmental regulations (Paulson, 2007).

Military AMRO depots operate in a macro-environment heavily influenced by political factors from local, state and federal government organizations. The above political influences are a sampling of the variety of macro-environmental political factors that firms competing in the military AMRO industry must take into consideration.

B. ECONOMIC

Economic factors refer to the economic structure of a society and its influence on the military AMRO industry.

- *Impact of recent economic trends on the industry.* The global credit crisis of 2008 and 2009 caused federal officials to inject large amounts of capital into the banking system. The injection of funds into the banking system has led elected federal officials to search for other federal programs to cut in effort to compensate for this expenditure. Congressman Barney Frank of Massachusetts, in *The Nation*, stated his belief that a cut of 25 percent in current defense spending could help compensate for the recent federal expenditures made to minimize these economic downturns (Frank, 2009). The impact of drastic reductions in the defense budget would have a direct impact throughout the military including participants in the military AMRO market.

- *Pressure to increase use of public/private partnerships.* DoD has experienced increasing pressure from Congress and the Executive Branch to supplement maintenance capital expenditures through the use of public/private partnerships (Leos, Rouleau, & Wadsworth, 2007). While these partnerships are expected to produce results that decrease DoD expenditure on capital and shift some of the military depot work to civilian

partners, the quantity of programs is lacking (Solis, 2008). Only two percent of the total U.S. military AMRO budget is involved in these public/private partnerships (Stewart, 2005).

Economic factors that were not a concern before the institution of the Navy Working Capital fund and the increased competition dictated by U.S.C. Title 10, are now a factor that must be accounted for by FRCSW. As competition continues to increase, FRCSW will need to include these economic factors in future strategic plans.

C. SOCIAL

Social factors refer to the demographics and cultural influences that customers, partners and the workforce experience in the macro-environment.

- *Difficulties in obtaining qualified workforce.* Both commercial and military AMROs compete for the same executive, engineering support and technical workforce. "International experience, improved technical competence for new equipment, and business acumen to handle consolidation, and outsourcing, are key executive competencies required for MRO companies in the future" (Edmonds, 2008). FRCSW will continue to compete with both military depots and commercial AMRO providers for qualified and experienced labor.
- *Workforce Demographic concerns.* Over a quarter of the aerospace workforce is currently of retirement age with an average production worker's age of 53 and average engineer's age of 54 (U.S. Department of Labor [Employment & Training Administration], 2005). Education of young, qualified AMRO technicians has become a political concern; California State Senator Gloria Romero has proposed pre-apprenticeship programs for high school upperclassmen to begin training aerospace technicians to fill vacancies left by retiring baby-boomers (Romero, 2009).

- *High cost of living and operating in San Diego Area.* Yearly cost of living estimates prepared by the Council for Community and Economic Research reveal that San Diego had a cost of living index of 143.8 in 2008, while the national average was 100 (City-Data, 2008). This compared to the Air Force's Western depot in Ogden, UT where the cost of living index was 83.4 in 2008 (City-Data, 2008). Average wages in 2007 for San Diego County were $61,793 while in Weber County, where Ogden is located, average wages were $52,154 (City-Data, 2008). Disparity between costs of living in the two regions could influence qualified workers to migrate to areas with lower costs of living.

Changing demographics and the high cost of living in San Diego County are social factors that could greatly affect the future workforce at FRCSW. Future strategic plans should account for these social factors.

D. TECHNOLOGICAL

Technological factors examine the potential impact of new technologies or new applications of old technologies on the industry.

- *Increasing use of software integration.* Successful commercial and private military AMROs have adopted supply-chain management and enterprise management software in effort to cut costs and improve efficiency (Aircraft Commerce, 2007). Enterprise management programs offer firms the ability to integrate maintenance activities and back office functions such as accounting and human resource management to optimize flexibility and resource allocation (SAP, 2007). Supply-chain management software improves visibility throughout the supply process and aligns the value chain by the use of parts triggering procurement of replacement supplies (Cambashi, 2008). Advances in management software technology will continue to provide opportunities for firms to differentiate themselves in the industry.

Previous chapters have discussed in-depth the impact of emerging technologies on the industry and FRCSW. The U.S. military aviation enterprise is a technology driver and thus, the military AMROs must maintain the expertise and flexibility to accommodate technological advancements.

VI. KEY SUCCESS FACTORS

An examination of the industry structure provides a forum within which the factors that determine the success of a firm in an industry can be analyzed. These key success factors are those that directly impact the ability of a firm to be successful in its specific industry. Identifying the key success factors is critical to understanding what makes a firm viable in the long-term. Firms have four sources of key success factors (KSF); they are: 1) the industry, 2) competitive position, 3) environmental factors, and 4) temporal factors (Morrison, 2009). Industry KSFs are those factors that are common to all participants in the industry and typically include factors that are industry-specific. Competitive Position KSFs are those factors that an individual firm will implement to distinguish itself from its competitors in the industry. Environmental KSFs are those factors that exist in the macro business environment that a firm must consider to be successful. Temporal factors are those factors that are important due to the occurrence of one-time events; while temporal factors are critical to continual internal analysis, they are not addressed in this paper.

The AMRO industry, due to the conglomeration of public and private firms competing in the same industry, contains KSFs that are specific to only private firms or government depots. The analysis conducted on the industry takes into account this relationship and stresses the importance of these two entities working together in the industry.

The following paragraphs outline each KSF, categorize the source of the KSF in boldface, and provide justification for its selection.

1) **Industry –** *Attract and maintain a technically-proficient workforce.* Skill level and expertise requirements drive the search for talent in the industry. Both commercial and military MROs are searching for this talent, as illustrated in this quote by Glenn Brown, Group General Manager for Associated Businesses at Qantas Engineering, Technical Operations, and Maintenance Services: “the capability and availability of key MRO talent, from

the technician and mechanics on the shop floor, up to the executive suite, are our most consistent risk and success factors" (Edmonds, 2008). Teams of 10 to 15 technically-proficient workers are required to conduct field maintenance on a single military aircraft (Stewart, 2005). These requirements impose hundreds of thousands of dollars in training costs to develop the required skills to perform the maintenance.

2) **Industry –** *Engineering expertise to provide engineering support and develop improved repair process and procedures.* The complexity and detailed nature of AMRO requires successful depots to provide organic engineering support. "For those problems that arise, that are unique, FRCSW works with a large staff of engineers to solve nearly any problem" (Kelly, 2008). As new airframes and modifications are developed, engineering input is critical in designing new and inventive maintenance processes. "The engineers and artisans at FRCSW went to work developing a technique to do what was undoable: remove and replace the center barrel section of the aircraft (Kelly, 2008)**.**"

3) **Competitive Position –** *Ability to conduct strategic planning for future product lines.* The U.S. DoD operates over 150 different airframe or airframe variants, each requiring specialized maintenance (Aviation Week & Space Technology, 2009). There are over 60 airframes in various stages of development that potentially could become production airframes, and this does not include possible new variants of existing airframes (Global Security, 2009). Strategic planning to anticipate which airframes will be accepted, and becoming a provider for that airframe, positions a firm for continued viability within the industry (Michaels, 2008).

4) **Environment –** *Develop and sustain an aggressive marketing plan.* While the customer base for military AMRO is concentrated, the competition for this work is not (Edmonds, 2008). For a firm to remain viable in the industry, they need to market their capabilities aggressively to all potential customers, partners and stakeholders. It is critical for military AMRO depots to

vigorously seek out and establish partners. Partners can provide the depots with core competencies they do not have, or offer their partner a way to leverage the depot's core competency to the benefit of both firms. Stakeholders, including state and federal elected officials, the local population and labor unions, while not necessarily directly involved in the military AMRO market, can be greatly affected by or can greatly influence the actions of large military depots. Development and implementation of a marketing plan that addresses both the concerns of potential partners and sells the value of the depot to the stakeholders is critical in ensuring continued viability.

5) **Industry –** *Leverage the firm's capital to establish and maintain core competencies required to support military aviation enterprises.* AMRO firms are required to invest in both human capital and fixed assets to enter the market. This investment requires that a total asset management approach is taken to ensure that the proper equipment and manpower is purchased to optimize the investment in working capital. "The ability to access and accurately understand the configuration and location of these assets, inventories and tools enables organizations to operate, support and service these resources on a more cost-effective basis" (Siemens PLM, 2008). Utilizing a total asset management approach assists firms in focusing their efforts on core competencies required by the military aviation enterprise (Siemens PLM, 2008).

6) **Competitive Position Transitioning to Industry –** *Implementation and continual improvement of lean, six sigma and theory of constraint practices.* "Those that do operate such programs [referring to lean and six-sigma] have seen average benefits (in cost reduction, turn-time improvement, and so on) in the range of 25 to 35 percent. Over the next few years, MRO companies that fail to make these investments will likely be unable to compete with their more efficient peers (Whyman, 2007)." Navy FRCs have implemented a process referred to as AIR*Speed* that combines these practices in effort to

instill a culture of continuous improvement that help ensure their competitiveness in future markets (Kelly, 2008).

7) **All –** *Establish and maintain effective public/private partnerships.* Partnerships create an opportunity for DoD organic depots to engage with private firms in extensive business relationships beneficial to the depots, the private firms and the warfighters. "By combining government capability, assets, and resources with corresponding contributions from the private sector, these arrangements leverage organic resources [DoD depots], increase the value of existing inventory, and generate sources of revenue" (Assistant Deputy Under Secretary of Defense for Maintenance Policy, Programs and Resources, 2005).

While this list of KSFs is by no means exhaustive, it presents examples of factors industry leaders consider in the development and implementation of their corporate strategy. Consideration of firm-specific KSFs is critical in developing an individual firm's strategic plan that takes into account that firms core competencies and market position (Morrison, 2009).

VII. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSIONS

As FRCSW develops, their long-term strategic plan, they should remain cognizant of the industry and macro-environmental forces acting upon them. Recognition of these forces and their impact on the industry will enable FRCSW to react to the changing environment and become proactive in the AMRO industry. As the industry continues to expand into the private sector, continuous analysis of the external environment will be necessary to ensure FRCSW's strategic plan remains viable. FRCSW's ability to remain an industry leader will become more dependent upon their ability to assess the industries environmental changes and adapt their core competencies to for the emerging needs of the U.S. Naval Aviation Enterprise.

B. RECOMMENDATIONS

Development of an industry analysis provides a firm with a consolidated picture of the market environment within which they operate. Understanding this environment and leveraging the opportunities presented in the analysis will allow a firm to increase its competitive position within the market. The focus of the industrial analysis is the eventual development of key success factors which allow a firm to concentrate their resources on obtaining those factors through use of their core competencies. The following recommendations utilize Key Success Factors provided in Chapter VI to help FRCSW identify their core competencies and determine a method to further leverage these core competencies to increase future work.

1. *Incorporate an external industrial analysis into the current strategic planning process.* Inclusion of an external industrial analysis will allow FRCSW to further understand the marketplace within which they compete. Subscription to annual industry studies and market research conducted by firms like Frost & Sullivan, AeroStrategy and OAG Aviation Solutions will help in developing FRCSW's long term strategic plan. These research studies provide market data, forecasts, and trends to allow

FRCSW to assess its market position and possible future opportunities. Review of this data should become standard during strategic planning sessions.

2. *Market FRCSW as the industry leader in corrosion repair.* Through our research and discussions with staff at FRCSW the movement of DoD to a "purple" depot system for AMRO seems inevitable. As this conversion takes place it will be critical for individual depots, such as FRCSW, to market their unique capabilities to lawmakers and DoD leadership differentiating themselves from one another and communicating the value of their capabilities. At FRCSW, in our opinion, one of the core competencies that differentiates them from their Army, Air Force, and civilian competitors is their ability to conduct invasive corrosion repairs through innovative and technically advanced methodologies. The experience gained by FRCSW in the repair of aircraft exposed to salt water and extreme corrosive environments should be marketed as the core competency that differentiates FRCSW from other DoD depots. Successful marketing of this capability could enable FRCSW to become a DoD CITE for airframe heavy repair for all airframes experiencing extensive corrosion.

3. *Engage other AMRO depots in information sharing of process improvement techniques.* Take the lead by inviting Air Force and Army Depot commanders and AIR*Speed* equivalent officers to tour FRCSW and conduct joint lessons learned and best practices information exchanges. Following the visit of other depot commanders arrange for FRCSW command team to conduct a reciprocal visit at these entities. Conduct short-term personnel exchanges with both technicians and back/front office personnel to encourage information sharing. A starting point for developing these relationships could be sharing the results of this thesis with Army and Air Force depots.

4. *Conduct reciprocal site visits with commercial AMRO depots.* Visits with commercial entities such as United Services in San Francisco and Delta Tech Ops in Atlanta could provide similar benefits of visits with DoD depots and should also be arranged. These site visits should include line supervisors and Product Managers to allow for idea sharing at the deckplate level. Including members of the business office would allow further exploration and sharing of marketing ideas and potential public/private partnerships. Commercial industries have years of experience at engaging in free market competition, a new concern for military depots. Sharing of lessons learned and management techniques from these depots will provide additional insight into private business practices.

5. *Proactive development of technical aerospace workforce.* Partner with local high schools to inform upperclassmen of the employment opportunities that exist in the AMRO industry and at FRCSW in particular. These partnerships could include visits by FRCSW employees to the high schools allowing students to gain first-hand knowledge of the opportunities that exist in the aerospace industry. Contact California State Senator Gloria Romero, who is currently proposing legislation to recruit and train high school students for employment in the aerospace industry, for state assistance in these efforts.

6. *Proactive development of professional engineering and management workforce.* Develop and institute internship opportunities for engineering students at local universities to increase interest in aerospace engineering for AMRO. Similar opportunities should also be developed to attract MBA students with backgrounds in financial management, supply chain management and logistics engineering. These internships could present opportunities for successful interns to return to FRCSW in a permanent position.

7. *Explore opportunities to enter the UAV MRO market.* Congressional Budget Office studies have proposed the option of replacing large portions of the current manned fighter aircraft fleet with both land and carrier based UAVs (Eveker & Arthur, 2009). Congressional decisions to increase the UAV force and reduce manned aircraft may have a significant impact on FRCSW unless they are able to obtain maintenance capabilities and develop the necessary skills to provide MRO services for UAVs.

8. *Explore opportunities to capture outsourced military depot level maintenance.* Currently the Army outsources all of its fixed wing depot level maintenance to either the Air Force or private firms. While the fleet of fixed wing aircraft in the Army is small, core competencies in aircraft such as the E-2/C-2 provide FRCSW with the background in narrow body transport type aircraft necessary to compete for these contracts. Close examination of other services outsourced work may provide additional opportunities for FRCSW to leverage their core competencies and bring in more work.

9. *Explore opportunities to develop public/private partnerships that utilize the engineering expertise of FRCSW.* Engineers at military depots are intimately familiar with the equipment and systems they work with. Partnering with OEMs and private firms by contributing engineering expertise to the partnership would expand the public/private partnership opportunities offered by FRCSW. The engineering requirements for small firms can constitute a large portion of the production costs. Military depots contracting out these consultant-type services would expand the capabilities of their private partners.

10. *Analyze production lines to determine excess capacity and market that capacity.* Encourage product managers to determine excess capacity in each product line and provide that information to the business office. The business office can then utilize this information to market available capacity to private firms and military entities outsourcing maintenance

work. The production line analysis should include costs for expanding shifts and analysis of the effective capacity of each link in the value chain of that product line. Marketing should focus on process capabilities vice current production line implementation.

C. AREAS FOR FUTURE STUDY

As a result of this project opportunities exist for future study; the following list proposes specific topic areas of interest:

- Develop a plan to coordinate with State Senator Gloria Romero on her initiatives to engage San Diego area high school students in the aerospace industry to ensure FRCSW gains increased exposure to these potential employees.
- Consolidate a list of best practices and lessons learned at all military AMRO depots.
- Conduct a market study on the UAV MRO market with a focus on potential opportunities for FRCSW.
- Examine opportunities for DoD to unify AMRO across service lines and develop a truly "purple" approach to aviation depot level repairs. One methodology that could be used is examination of core competencies at each depot in DoD and developing a system that leverages these core competencies to the greatest benefit of the DoD. An example of this would be designating FRCSW as the airframe heavy corrosion repair CITE.

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LIST OF REFERENCES

Aircraft Commerce. (2007, March). *Successful MRO system.* Retrieved May 11, 2009, from Aircraft Commerce: http://www.mirotechnologies.com/pressroom/newsArticles/ISSUE50MTCE_IT.pdf

Armstrong, M. B. (2005, October 9). *Blue Water Mac Armstrong Presentation.* Retrieved April 28, 2009, from Author Stream: http://www.authorstream.com/Presentation/Gulkund-37636-Blue-Water-Mac-Armstrong-Solutions-Inc-Outline-Aviation-Needs-Statement-Business-as-Entertainment-ppt-powerpoint/

Assistant Deputy Under Secretary of Defense for Maintenance Policy, Programs and Resources. (2005, March). *Compendium of Depot Maintenance Public-Private Partnerships.* Retrieved May 4, 2009, from Defense Acquisition University Acquisition Community Connection: https://acc.dau.mil/GetAttachment.aspx?id=32199&pname=file&aid=6066&lang=en-US

Aviation Week & Space Technology. (2009). 2009 World Military Aircraft Inventory. *Aviation Week & Space Technology , 170* (4), 240-247.

Berger, J. M. (2005, November 9). *MRO Facilities for the Americas Region.* Retrieved March 22, 2009, from SH&E International Air Transport Consultancy: http://www.sh-e.com/presentations/Berger_MRO_Speech_11-05.pdf

Bone, E., & Bolkcom, C. (2003, April 25). *Unmanned Aerial Vehicles: Background and Issues for Congress.* Retrieved April 4, 2009, from Federation of American Scientists: http://www.fas.org/irp/crs/RL31872.pdf

Butler International. (2008, September). *Aerospace Industry Trends.* Retrieved April 28, 2009, from Butler International: http://www.butler.com/newsletter/aerospace/september_newsletter.htm

Cambashi, J. F. (2008, April). *Increased Performance of Global Supply Chains and Operations with Manufacturing Execution Systems.* Retrieved May 14, 2009, from SAP for Aerospace and Defense: http://www.sap.com/industries/aero-defense/large/brochures/index.epx

Carpenter, R., & Henderson, A. (2008, January). *Keep Them Flying: Find your winning position in the MRO game.* Retrieved April 5, 2009, from IBM Global Business Services: http://www-304.ibm.com/jct03004c/easyaccess/fileserve?contentid=174266

Chandler, C. H. (2005, November 1). *Air Force Instruction 31-401: Information Security Program Management.* Retrieved April 28, 2009, from Federation of American Scientists: http://www.fas.org/irp/doddir/usaf/31-401.htm

Choo, B. S. (2004, July 1). *Best Practices in Aircraft Engine MRO: A Study of Commercial and Military Systems.* Retrieved March 20, 2009, from Dspace: http://dspace.mit.edu/bitstream/handle/1721.1/17761/56525247.pdf?sequence=1

Chrisman, H. (2008, April). *The PBL debate: An Overview of the Global Military Aircraft MRO Market.* Retrieved March 31, 2009, from http://www.aerostrategy.com/downloads/speeches/speech_66.pdf

City-Data. (2008). *Ogden, Utah (UT) Detailed Profile.* Retrieved May 11, 2009, from City-Data: www.city-data.com/city/Ogden-Utah.html

City-Data. (2008). *San Diego County, California (CA) Detailed Profile.* Retrieved May 11, 2009, from City-Data: http://www.city-data.com/county/San_Diego_County-CA.html

Commander Naval Air Forces. (2009). *Naval Aviation Maintence Program (COMNAVAIRFORINST 4790.2A CH-1).* San Diego, CA: Commander Naval Air Forces.

Datamonitor. (2008, December). *Aerospace & Defense in Germany.* Retrieved April 6, 2009, from Datamonitor: http://74.125.47.132/search?q=cache:-AYBlspyMPMJ:www.promexico.gob.mx/work/sites/Promexico/resources/LocalContent/941/2/AerospaceAndDefense.pdf+%22five+forces%22+analysis+military+mro&cd=10&hl=en&ct=clnk&gl=us&client=firefox-a

Defense Acquisiton University. (2009). *Business Case Analysis.* Retrieved May 4, 2009, from Defense Acquisition University's Acquisition Community Connection : https://acc.dau.mil/CommunityBrowser.aspx?id=32524

Doan, C. (2007, April). *The Global MRO Forecast - A Look Forward 2007-2017.* Retrieved May 19, 2009, from Team SAI: http://www.teamsai.com/newsfiles/2007_TeamSAI_Global_MRO_Forecast_070415.pdf

Doan, C. (2008, April). *The Global MRO Forecast: A Look Forward 2008-2018.* Retrieved March 25, 2009, from North American MRO Convention April 2008: http://www.aviationweek.com/conferences/html/mro08/2008_teamSAI%20global%20doan%202pm.pdf

Edmonds, B. (2008). *The Changing Global MRO Market…Consolidation, Outsourcing, Talent Search.* Retrieved May 3, 2009, from Heidrick & Struggles: http://www.heidrick.com/NR/rdonlyres/38A96DA4-071D-4FEE-9539-B9FE3F91C3C7/0/ThechangingglobalMROmarketbe.pdf

Eveker, K., & Arthur, D. (2009). *Alternatives for Modernizing U.S. Fighter Forces.* Washington D.C.: Congressional Budget Office.

Farrell, B. S. (2008, May 22). *Personal Clearances: Key Factors for Reforming the Security Clearance Process.* Retrieved April 20, 2009, from Government Accounting Office: http://www.gao.gov/new.items/d08776t.pdf

Fisher, B. E. (1996, July). *Dissolving Medical Waste.* Retrieved April 28, 2009, from Environmental Health Perspectives: http://www.ehponline.org/docs/1996/104-7/innov.html

Fleet Readiness Center Southwest. (2007). *Best Manufacturing Practices.* Retrieved November 20, 2007, from Naval Aviation (NAVAIR) Depot, North Island - San Diego, CA: Best Practices: http://www/bmpoce.org/bestpractices/internal/nadep/index.html

Fleet Readiness Center Southwest. (2007). *Fleet Readiness Center Southwest.* Retrieved November 30, 2007, from Homepage: http://www.frcsw.navy.mil/frcsw

Frank, B. (2009, February 11). *Cut the Military Budget -- II.* Retrieved May 9, 2009, from The Nation: http://www.thenation.com/doc/20090302/frank

Frost & Sullivan Research. (2008). *Commercial and Military Aircraft and Engine MRO Market Research Overview.* Retrieved April 24, 2009, from Frost & Sullivan Research: http://www.dri.co.jp/auto/report/fs/fsn36108.htm

General Services Administration Department of Defence. (2009). *Federal Acquisition Regulation.* Washington, D.C.: General Services Administration Department of Defence.

Global Security. (2007, September 23). *MQ-1B Predator.* Retrieved April 11, 2009, from GlobalSecurity.org: http://www.globalsecurity.org/military/systems/aircraft/mq-1b.htm

Global Security. (2009, February 13). *US Military Aircraft.* Retrieved May 4, 2009, from Global Security: http://www.globalsecurity.org/military/systems/aircraft/index.html

Hemmati, V., Randell, M., Monk, T., & Pettigrew, T. (2008, October). *Barnes Group Equity adn Valuation Analysis.* Retrieved April 25, 2009, from Barnes Group Fall 2008: http://mmoore.ba.ttu.edu/ValuationReports/Fall2008/BarnesGroup-Fall2008.pdf

Holman, B. W. (2001, August 28). *Military Base Closures: Overview of Economic Recovery, Property Transfer and Environmental Cleanup.* Retrieved March 19, 2009, from General Accounting Office: http://web.ebscohost.com/ehost/pdf?vid=5&hid=7&sid=3690e131-2195-4e1c-8f56-9c5c557ed8a5%40sessionmgr2#db=bth&AN=18203740

Holman, B., Denman, J., Epstein, D., Knoepfle, G., Waytel, E., & Newton, P. (1998, November). *Army Industrial Facilities: Workforce Requirements and Related Issues Affecting Depots and Arsenals.* Retrieved May 4, 2009, from U.S. General Accounting Office: http://www.gao.gov/archive/1999/ns99031.pdf

Hunter, C. (2006, June). *Public-Private Partnerships and the Future of the Army Industrial Enterprise.* Retrieved February 22, 2009, from Lexington Institute: http://lexingtoninstitute.org/docs/784.pdf

InnovationPoint. (2007). *Industry Foresight as a Driver of Strategic Innovation - Understanding Emerging Trends for Business Growth.* Retrieved May 16, 2009, from Innovation Point: http://www.innovation-point.com/industry_foresight.pdf

Inside Defense. (2009, April 8). *DSCA: Despite Rising FMS, Economic Downturn may Curb Some Deals.* Retrieved May 6, 2009, from Inside Defense: http://www.insidedefense.com.libproxy.nps.edu/secure/display.asp?docnum=missile-15-7-8&f=defense_2002.ask

Jackman, F. (2009, April 9). *MRO Market Now Pegged at $45.7 B.* Retrieved April 20, 2009, from AviationWeek.com: http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=om&id=news/om409cvr.xml

Jackman, F. (2005, Feb). *Steady Growth for Military Aircraft MRO*. Retrieved May 21, 2009, from Aviation Week: http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=om&id=news/om0105cvr.xml&headline=Steady%20Growth%20for%20Military%20Aircraft%20MRO%20Spending

Kaplan, S., & Johnston, R. E. (1998). Dislocations-Drivers of Industry Evolution and Corporate Growth. *Strategic Change* , 13-18.

Kelly, M. (2008). *Fleet Readiness Center Southwest Command Brief.* San Diego, CA: Fleet Readiness Center Southwest.

Kovacic, W. E., & Schooner, S. L. (2005, December). *A Modest Proposal to Enhance Civil/Military Integration: Rethinking the Renegotiation Regime as a Regulatory Mechanism to Decriminalize Cost, Pricing, and Profit Policy.* Retrieved April 13, 2009, from Social Science Research Network: http://papers.ssrn.com/so13/papers.cfm?abstract_id=869982

KPMG. (2003, April). *Snapshot World MRO Sector*. Retrieved April 2, 2009, from KPMG: http://www.kpmg.ca/en/industries/cib/transportation/documents/worldmrooutlook.pdf

Leos, L., Rouleau, P., & Wadsworth, M. (2007, August 15). *Strategic Financing of DoD Resources and Budget Policies.* Retrieved May 6, 2009, from Naval Postgraduate School: http://bosun.nps.edu/uhtbin/hyperion-image-exe/07jun%5fleos%5fmba.pdf

Lepore, B. J. (2007, May). *Defense Budget - Trends in Operation and Maintenance Costs and Support Services Contracting*. Retrieved May 16, 2009, from Government Accountability Office: http://www.gao.gov/new.items/d07631.pdf

Magalhaes, M. (2004, March 8). *Military Aircraft Maintenance, Repair & Overhaul - Wake-up Call to a Silent Revolution?* Retrieved April 28, 2009, from Frost & Sullivan: http://www.frost.com/prod/servlet/market-insight-top.pag?docid=10899576

Marcontell, D. A. (2009, Feb). *Airline Health and Wealth.* Retrieved March 15, 2009, from Aero-Engine Cost Management Conference Presentations: http://www.teamsai.com/newsfiles/2009_TeamSAI_Airline_Health_IAH_090204_FINAL.pdf

Marshall Aerospace. (2008). *Marshall Aerospace Projects*. Retrieved April 20, 2009, from Marshall Aerospace: http://www.marshallaerospace.com/a400mFTB.php

McGladrey Capital Markets LLC. (2009, April). *Industry Review and Analysis.* Retrieved April 29, 2009, from Aerospace and Defence Group: http://www.mcgladreycm.com/portals/0/quarterly%20industry%20reviews/209_q1qir_aerospaceanddefence.pdf

Michaels, K. (2008, October 7). *Outlook of the Global Aerospace Maintenance, Repair and Overhaul Market.* Retrieved March 27, 2009, from http://webfiles.wichita.edu/cedbr/Michaels.ppt

Moore, J. (2008). Retrieved November 1, 2008, from BRAC 2005: The New Integrated I&D Level Maintenance: http://www.av8.org/brac-05

Morrison, M. (2009, May 2). *Critical Success Factor Analysis, Determine the Critical Success Factors for Your Organization.* Retrieved May 4, 2009, from Rapidbi: http://rapidbi.com/created/criticalsuccessfactors.html

NAVAIRSYSCOM. (2009, February 5). *United States Fact File.* Retrieved March 29, 2009, from Navy.mil: http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=1200&ct=1

Office of Congressman Walter B. Jones. (2009). *House Military Depot and Industrial Facilities Caucus.* Retrieved May 7, 2009, from Congressman Walter B. Jones: http://jones.house.gov/content.cfm?id=419

Office of the Assistant Secretary For Aviation and International Affairs. (1998, June). *Profile: Regional Jets and Thier Emerging Roles in the U.S. Aviation Market.* Retrieved May 20, 2009, from United States of America Department of Transportation: http://ostpxweb.dot.gov/aviation/domav/regjets.pdf

Palmer, D., & Kaplan, S. (2007). *A Framework for Strategic Innovation: Blending strategy and creative exploration to discover future business opportunities*. Retrieved May 15, 2009, from Innovation Point: http://www.innovation-point.com/strategic%20innovation%20white%20paper.pdf

Paulson, R. (2007, June 13). *White House Award Honors FRCSW Environmental Efforts.* Retrieved May 1, 2009, from Navy.mil: http://www.navy.mil/search/display.asp?story_id=30029

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors.* New York: The Free Press.

PR Newswire. (2008, December 3). *Global MRO Spend On Military Aviation to Increase By 14.9% Over the Next Decade, Reports OAG*. Retrieved April 3, 2009, from http://br.sys-con.com/node/766349

Provenmodels. (2009). *PEST Analysis.* Retrieved May 5, 2009, from Provenmodels: http://www.provenmodels.com/32/pest-analysis/

Romero, G. (2009, February 27). *Career Technical Education - Aerospace Factsheet.* Retrieved May 11, 2009, from Senator Gloria Romero: www.sen.ca.gov/romero

Sanyal, S. (2009, March 16). *Aviation MRO Segment Poised to Grow*. Retrieved April 22, 2009, from Sify Finance: http://sify.com/finance/fullstory.php?id=14870760

SAP. (2007). *Driving Maintenance Excellence for Airlines.* Retrieved May 11, 2009, from SAP for Aerospace and Defense: http://www.sap.com/industries/aero-defense/large/brochures/index.epx

Secretary of the Navy. (2006). *Department of the Navy Personnel Security Program (SECNAVINST M-5510.30).* Washington D.C.: Chief of Naval Operations (N09N Special Assistant for Naval Investigative Matters and Security).

Secretary of the Navy. (2002, July 19). *Designation of Centers of Industrial and Technical Excellence Under 10 U.S.C. 2474.* Retrieved January 12, 2009, from Defense Acquisition University: https://acc.dau.mil/GetAttachment.aspx?id=32191&pname=file&aid=6060&lang=en-US

Siemens PLM. (2008, March). *Powering Maintenance, Repair and Overhaul for Aerospace and Defense.* Retrieved May 4, 2009, from Siemens PLM: http://www.plm.automation.siemens.com/en_us/Images/maintenance%20repair%20%20overhaul%20(MRO)%20exec%20brief%20W%202_tcm53-4802.pdf

Society for Automotive Engineers. (2007). *Welcome to the Basics of AS9100.* Retrieved April 15, 2009, from AS9100 Store: http://www.AS9100store.com/basics-of-AS9100.aspx

Solis, W. (2008). *Depot Maintenance: DoD's Report to Congress on Its Public Private Partnerships at Its Centers of Industrial and Technical Excellence (CITEs) Is Not Complete And Requires Additional Information.* Washington D.C.: United States Government Accounting Office.

Solis, W. M. (2008, July 1). *Depot Maintenance: DoD's Report to Congress on Its Public-Private Partnerships at Its Centers of Industrial and Technical Excellence (CITEs) Is Not Complete and Additional Information Would Be Useful* . Retrieved February 17, 2009, from Government Acountability Office: www.gao.gov/htext/d08902r.html

Stewart, D. (2005, February). *Taming the Tail.* Retrieved March 28, 2009, from AeroStrategy Management Consulting: http://www.aerostrategy.com/downloads/commentaries/commentary_feb05.pdf

Tegtmeier, L. A. (2006, July 26). Military MRO Forcast. *Overhaul & Maintenance* .

U.S. Army Materiel Command. (2004). *Handbook of Army Public-Private Partnering.* Retrieved January 17, 2009, from Commerce Center of Southeast Iowa: http://www.commercecenterseiowa.com/P3Handbook.pdf

U.S. Department of Labor (Employment & Training Administration). (2005, May). *America's Aerospace Industry: Identifying and Addressing Workforce Challenges.* Retrieved May 12, 2009, from Report of Findings and Recommendations For the President's High Growth Job Training Initiative in the Aerospace Industry: http://www.doleta.gov/brg/indprof/aerospace_report.pdf

U.S. House of Representatives. (2008, January 8). *Title 10 - Armed Forces.* Retrieved March 15, 2009, from Downloadable U.S. Code: http://uscode.house.gov/download/title_10.shtml

U.S. Marine Corps Material Command. (2004). *Depot Level Maintenace Program Handbook.* Retrieved April 14, 2009, from U.S. Marine Corps Material Command: http://www.logcom.usmc.mil/files/DLMPHandbook.pdf

Under Secretary of Defense for Acquisitions Technology and Logisitics . (2007, April 25). *Department of Defense Instruction Number 4151.21.* Retrieved March 10, 2009, from Public Private Partnerships for Depot Level Maintenance: www.dtic.mil/whs/directives/corres/rtf/415121x.rtf

Whyman, O. (2007). *Aviation MRO: the Next Place to Land for Private Equity Investors.* Retrieved May 2, 2009, from Oliver Whyman: http://www.oliverwyman.com/ow/pdf_files/OW_EN_AAD_2008_PrivateEquity.pdf

Wynne, M. W. (2005, January 4). *2005 Base Closure and Realignment Selection Criteria*. Retrieved May 7, 2009, from Under Secretary of Defense Acquisitions, Technology and Logisitics: http://www.defenselink.mil/brac/docs/criteria_final_jan4_05.pdf

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